Waste Reduction Assessment for the Fabricated Metal Products Industries (SIC Code Group 34)

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UT Center for Industrial Services
What is the Center for Industrial Services?

As a statewide industrial extension program of the University of Tennessee, CIS is dedicated to helping managers of Tennessee manufacturing firms find practical solutions to the problems they face daily. CIS operates a statewide waste reduction program with funding from the Tennessee Department of Environment and Conservation. Through this program, CIS provides training and on-site waste reduction technical assistance for Tennessee companies.

For help with your manufacturing problem or question, call the CIS main office in Nashville at (615) 332-8637.
To accomplish waste reduction, you must first identify and characterize the waste streams. The most common waste streams found in metal fabricating operations will be described in this section, along with the regulatory requirements and other issues associated with them. Suggestions for reducing the streams will be given in a later section.

The following definition of a waste stream may help when you begin to try to identify them:

A waste stream from your plant is simply any material which enters your plant, but does not exit as part of your final product, being instead discarded into the environment. This applies whether the ultimate destination is the air, the land, the waters of our planet, or even a recycling or recovery agent.

Metal fabricators generate a number of different waste streams. Some are generated by almost all fabricators; others may or may not be generated, depending on the specific nature of the business. They may be generated by the fabricating operations themselves, by materials handling and warehousing, by cleaning operations, by finishing or coating operations, by maintenance operations, even by the plant office and lunchroom.

**SOLVENT WASTES**

Solvent wastes are generated in metal fabricating plants by these major routes:

- Degreasing items before painting, plating, or otherwise applying surface coatings;
- Removing metalworking fluids to expedite inspection or to prevent contact with employees, packaging materials, etc.;
- Cleaning manufacturing equipment or forklifts and other vehicles;
- Cleanup of painting equipment at color changes or shut-down;
- Solvent evaporation.

All liquid solvent wastes are prohibited from landfill disposal, and most fall into one or more categories of hazardous wastes as defined by RCRA - either D001 (ignitable, flash point below 140°F) or F001-F005 (listed wastes). Also, if the process using the solvent causes it to be contaminated with a hazardous substance, it must be subjected to the Toxic
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Characteristic Leaching Procedure (TCLP) to determine whether it is hazardous because of the Toxicity Characteristic (D004-D043). The only possible exception is solvents which can pass the TCLP, are not listed, and have flash points above 140°F. Although prohibited from landfill disposal, they may be handled as if they are used oils.

One of the largest solvent waste streams in many plants, and one which is often not even considered when assessing wastes because it is not a visible stream, is solvent lost to the atmosphere through evaporation. Such losses are commonly regulated as air pollutants (Volatile Organic Compounds or "VOC's"). Sources may be "point sources" such as a paint spray booth or drying oven, or "fugitive emissions" such as evaporation from the surface of a sink, tub, storage tank, etc.

Specific equipment likely to be sources of solvent wastes will include:

- Vapor degreasers;
- Paint spray booths or other protective coating apparatus;
- Paint kitchens and paint equipment cleaning stations;
- Drying and/or curing ovens;
- Sinks, tubs and vats used for cleaning parts and dies; and,
- Containers, rags, sprayers, and aerosol products used for manual cleaning of production equipment.

**USED OILS**

In metal fabricating shops, used oils, other than those in the metalworking fluids discussed below, are usually generated by maintenance operations. They include hydraulic fluids, lubricating oils and sometimes transformer oils and automatic transmission fluid. These materials enjoy an exemption from regulation as hazardous wastes as long as they have flash points higher than 140°F, in order to encourage recycling or energy recovery. However, disposal of any liquid, including used oils, in a sanitary landfill or applying to the ground (such as road oiling for dust control) is unlawful. EPA Administrator William Reilly signed a final notice in October 1992 determining it is unnecessary to list recycled used oil as hazardous waste. EPA has listed management standards for used oil to protect human health and the environment while promoting recycling of used oil.

The management standards apply to all used-oil generators as well as treaters, transporters, re-refiners, etc. People who change their own oil (do-it-yourselfers) and farmers who generate 25 gallons or less of used oil per month are exempted. The standards are found in the new Part 279 of Title 40 of the Code of Federal Regulations.
Generators, including service stations, must:

» Clean up any spills or leaks from used oil,
» Maintain tanks or other containers in good condition and label them "used oil".
» When shipping more than 55 gallons of used oil for recycling, use a transporter with an EPA identification number.

Service stations who comply with the above requirements may accept used oil from do-it-yourselfers without becoming liable for emergency response costs or damage resulting from on- or off-site used oil releases. EPA believes this liability relief will encourage more service stations to collect used oil, thereby increasing consumer recycling.

Materials Containing Used Oils

Because of the prohibition against disposing of liquids in sanitary landfills, certain materials which might introduce liquid oil into landfills are also regulated. Primary items of concern are used oil filters and oil-soaked absorbent material such as the granular clay or "kitty litter" so commonly used to absorb oil spills.

- Oil filters must be disposed of as hazardous waste unless they have been drained and crushed according to specific guidelines. Tennessee has issued a state-wide Special Waste Approval for landfill disposal of oil filters which have been properly drained and mechanically crushed.

- Oil-soaked absorbent material must be subjected to the Toxicity Characteristics Leaching Procedure (TCLP) to determine whether it (a) must be disposed of as a hazardous waste, or (b) a Special Waste Approval can be obtained for landfill disposal. Landfill disposal is prohibited if the leachate obtained by the TCLP contains more than 10 ppm petroleum hydrocarbons.

METALWORKING FLUID WASTES

Metalworking fluids are used for both lubrication and cooling in various machining processes (e.g., turning, stamping, cutting, grinding, and shaping). Very few machining operations use a metal-working fluid which consists solely of oils. Because the ability to absorb and remove heat generated by friction between the tool and the workpiece is significantly more important than "lubricity" in a metal-cutting operation, the trend is to use a mixture which contains only enough oil to give a minor degree of lubrication, and as much water as possible to provide maximum heat-removal capacity. It should be obvious that if the fluid reaches a state where it is useless and must be discarded, disposal will be a problem, even though it is not classified as a hazardous waste, because of its mixture of components. As a matter of fact, contractors often charge more for metalworking fluid mixture disposal than for some hazardous wastes.
Metalworking fluids comprise 4 main categories:

- "Cutting oils", which are petroleum oils fortified with various additives such as sulfur compounds or metallic soaps;

- "Soluble oils", which are composed of 30% to 90% oil in the concentrated form, the remainder being surface-active agents. When diluted with water for various industrial uses, the oil-water mixture is a more or less stable, milky-looking liquid called an emulsion.

- Semi-synthetic fluids, which contain 1-30% oil in the concentrated form. This emulsion is much more stable than with "soluble oil", making it harder for contaminants to enter the system and cause problems.

- Synthetic fluids, which contain 0-1% oil. They usually appear to be a clear solution when extended with water. Oily contaminants are rarely able to penetrate this mixture.

The following symptoms indicate that the coolant needs replaced.

- It causes skin irritation among machine operators,

- It has gone rancid (the operators say it’s putrid and stinks like rotten eggs), and

- Tool life is falling off.

It need not happen! With a carefully designed and religiously followed management program, it is possible to essentially eliminate the conditions which commonly result in the disposal of metalworking fluid. This can result in substantial savings in both fluid purchases and disposal costs.

WASTE WATER

Waste water is generated in metals fabricating industries from such sources as:

- Water-curtain type paint spray booths;

- Electroplating systems;

- Anodizing systems;

- Parts cleaning systems, either acidic or alkaline;

- Paint stripping systems;
There are usually two options for disposing of wastewater:

- Discharge from the plant site directly or indirectly into an existing surface stream,
  
  or

- Discharge into a sewer system served by a Publicly Owned Treatment Works (POTW).

In the first case, even if the discharge is clean, potable tapwater, a permit under the National Pollutant Discharge Elimination System (NPDES) is required. In order to obtain an NPDES permit, it may be necessary to pre-treat the wastewater to eliminate certain pollutants prior to discharge to surface waters.

In the latter case, the local POTW is the regulating agency. If the discharge is anything other than domestic sewage, an industrial user agreement which sets concentration and total discharge quantity limits on specific pollutants and establishes sampling and monitoring procedures to ensure the limits are met probably will be required. Because some industrial pollutants interfere with a POTW's treatment process or may carry through to a POTW's discharge, on-site pretreatment to prevent such materials from entering the sewer system is usually required.

**SLUDGES**

The major types of sludges which appear as wastes in metal fabricating plants are:

- Paint-related sludges, which may include material scraped from painting booths and surroundings, paint solids skimmed from water-curtain type spray booths, or bottoms from paint solvent recovery stills;

- Sludges generated by treatment of electroplating, heat-treating or anodizing wastewater;

- Grinding sludge;

- Sludges from periodic clean-out of solvent or aqueous cleaning systems, sumps or grease traps.
Disposal options depend on both source and characteristics of the particular sludge:

**Most sludges generated by treating electroplating and heat-treating wastewaters are listed RCRA hazardous wastes (F006 - F012, F019), although there are a few exceptions.**

Paint-related sludges can be hazardous because of ignitability (D001) or toxicity (D004-D043) characteristics, and in the case of still bottoms, they may be listed wastes because of the particular solvent recovered in the still (F001-F005).

Because grinding sludge is usually a semi-solid mixture of finely divided metal particles and a metal-working fluid, prohibitions on introducing liquids to landfills usually prevent landfill disposal. Recovery and recycling options will be discussed later.

Clean-out sludges must be individually considered; they can be ignitable (D001), corrosive (D002), or toxicity (D004-D043) characteristic hazardous wastes or even non-hazardous.

In Tennessee, if a sludge is neither a listed nor a characteristic hazardous waste, Special Waste Approval from the state is still required for landfill disposal.

**CORROSIVE WASTES**

Metal fabricating plants generate corrosive (D002) hazardous wastes from cleaning and rust-removal operations. Such wastes may include:

- Spent pickling acids;
- Spent alkaline cleaning solutions;
- Discarded molten-bath (e.g., Kolene® process) alkali-salt cleaning mixtures.

By RCRA definition, only aqueous and liquid wastes are corrosive (D002) wastes. Therefore, only the first two of the above wastes would be considered D002 wastes.

The last, once allowed to solidify, would not be considered a RCRA corrosive waste, regardless of its corrosive properties. However, if the solidified mixture could have become contaminated with such metals as lead or chromium in the course of its use, it will be necessary to determine whether it passes the TCLP to characterize it. Although such waste may not be regulated under RCRA, most landfill operators will prohibit landfill disposal, if regulatory agencies do not. It should not be disposed of without appropriate precautions against leaching into groundwater and/or injury to personnel. Options such as dissolving and neutralizing, waste exchanges, etc. will be discussed in a later section.
METAL WASTES

Whether your products start as wire, sheet, plate, tubing or structural shapes, there is always some waste in converting it from the form in which it is received into the form which represents your product. Many fabricators do not consider metal scrap to be a waste, because they base product cost calculations on the raw stock required per unit -- some even treat whatever they receive from the scrap dealer as a welcome revenue item. However, when you consider that the price dealers pay for scrap is only a small percentage of the price you paid for the raw stock, it becomes clear that every pound of scrap is either reducing your profit or inflating the price you have to charge for your product. Reducing the amount of scrap generated to the practical minimum is one way to obtain a competitive edge over your peers in the business, and is worthy of attention.

An even more costly waste stream comprises rejectes which are often converted to scrap because reworking the items would cost more than discarding them. How costly this type of waste actually is depends on how far down the line toward finished product it got before it was rejected, because you are now discarding not only the materials, but also the labor and supplies required to bring it to that stage. If this waste stream is of significant size, it needs immediate and intensive attention!

PACKAGING WASTES

I. Wood Wastes

Primary sources of wood waste in metal fabricating plants will be:

- Wooden pallets;
- Crates, boxes, skids and dunnage from inbound materials;
- Wood waste from in-house crating and boxing operations.

Little or no characterization of these wastes is necessary. Reduction, recycle, re-use and disposal options will be discussed elsewhere.

II. Paper Products Wastes

No waste in any industrial establishment occurs in more forms or from more sources than paper products. This category includes office paper, wrapping paper from inbound goods, corrugated cardboard, paperboard products and various composites of which paper is a component. Places to look for paper products generation are:

- Office and computer room;
Shipping and receiving areas;

Storage and warehousing areas;

All production areas.

Almost all paper products, except those which are bonded to other materials (such as plastic) or have adhesive backs, or are soiled with oil, are prime candidates for recycling.

Miscellaneous Packaging Wastes

Many other waste streams are likely to be found, for example:

- **Plastics**
  - Stretch wrap and plastic strapping from inbound goods,
  - Trimmings or scrap from plastic components incorporated into the plant’s product,
  - Expanded polystyrene protective packaging,
  - Empty plastic drums and pails, from maintenance or housekeeping.

- **Miscellaneous Steel Items**
  - Steel strapping from inbound shipments,
  - Empty steel drums,
  - Empty paint and solvent pails and cans,

**OTHER WASTES**

- Used fuel, hydraulic fluid and oil filters.

- Blasting beads, shot, sand or grit.

- Aluminum soft-drink cans.

- Spent fluorescent light tubes, solvents, dry-cell batteries, aerosol cans, etc. from maintenance operations.
FABRICATED METAL PRODUCTS MANUFACTURERS

WASTE REDUCTION OPTIONS

INTRODUCTION

Reduction of any waste stream may be accomplished by one or more methods. The preferred method for any stream is one which prevents or lessens its generation in the first place. This is SOURCE REDUCTION.

If a waste cannot be eliminated by source reduction methods, then it is time to look at RECYCLING, which allows the material to be:

- Returned to the process from which it came (in-process recycling);
- Re-used as a raw material in another process or product in the same plant (on-site recycling); or
- Re-used as a raw material in a process at some other site (off-site recycling).

If neither source reduction nor recycling is feasible, then some sort of TREATMENT option may have to be considered. Treatment may reduce the volume of waste, return at least a part of it to its original form and purity, lessen the material's potential for harming the environment, or destroy the material by converting it into other substances. If a waste is to be destroyed by burning, it is desirable to recover its energy content by using it to replace a fossil fuel, if possible.

The "last resort" option is DISPOSAL. If a waste is hazardous by RCRA definition, the method of disposal is prescribed by law. It is expensive, and the law gives the generator "cradle-to-grave" responsibility for any harm his hazardous waste may cause the environment. WASTE REDUCTION is the surest way to lessen that expense and future liability. To ensure that this happens, Tennessee has set a state-wide goal of 25% reduction by June 30, 1995, and the Hazardous Waste Reduction Act of 1990 requires every generator to devise a written plan setting specific reduction goals and to report progress toward their attainment annually.

The Solid Waste Management Act of 1991 has mandated that non-hazardous solid wastes landfilled or incinerated in Tennessee be reduced by 25% (weight basis) by December 31, 1995. To this end, some 60 Solid Waste Management Regions, each consisting of one or more counties, have been formed. Each region is currently determining how to meet that goal. While plans have not been completed, there is no doubt the necessary infrastructure will involve considerable cost which will be passed on to waste generators in the form of disposal fees. It is obvious that reduction of non-hazardous waste will pay dividends just as it will with hazardous waste.
AWARENESS -- A POWERFUL WEAPON IN WASTE REDUCTION

In conducting many on-site waste reduction assessments in many types of industries and businesses, members of the UT-CIS' Waste Reduction Assistance Program (WRAP) have come to realize that an alarming amount of industrial waste is generated unnecessarily. The prime reason for this is that established procedures have been set up - often they just happened - with no consideration for waste generation. Therefore, a logical place to begin waste reduction is to make everyone in the organization aware of the influence their actions may have on waste generation rates through a training program, followed by participation in a facility-wide waste assessment. When a waste stream has been identified, those whose activities generate it should be asked questions such as:

What causes this material to become a waste?

Can we change our way of doing things to conserve the waste material?

Could we accomplish the same result in another way which won't generate the waste?

Could we substitute something less hazardous?

Could we recover, re-use or reclaim the waste?

Once waste awareness has been established throughout the organization, options to reduce wastes may originate from any quarter. For example, much of the non-hazardous waste generated in most plants arrives with incoming raw materials and supplies. A waste-aware purchasing department can be remarkably effective in helping to eliminate at the source unnecessary packaging materials, "throwaway" pallets, and similar material which becomes your solid waste.

Assistance in training, making waste assessments and establishing a waste reduction program is available from WRAP.

REDUCTION OPTIONS FOR INDIVIDUAL WASTE STREAMS

Regulations governing hazardous waste handling, storage, treatment and disposal impose limitations on your options. The options listed are believed to include only those allowed under Tennessee statutes. An Appendix follows this section with vendor lists, information sources, etc. for your use in evaluating options.
SOLVENT WASTES

I. Vapor Degreasing Solvent Wastes

A. Reduce vapor losses through better operating practices

Far too many users of vapor degreasers are actually using them as hot-solvent soak washers. Using them in this way negates the built-in solvent-conserving features. Two excellent publications on vapor degreaser operation are listed in the Bibliography. Following the procedures given there can make a dramatic difference in solvent waste generation and vapor losses.

Good housekeeping procedures can significantly affect the amount of solvent waste produced by vapor degreasers. These include:

- Liquid/liquid separators should be cleaned and checked frequently to avoid contamination of solvent with other cleaners or water which can lead to acid formation. Also, parts should not be allowed to enter the degreaser while wet;

- Promptly remove sludge collected at the bottom of the tank. This increases cleaning efficiency by not allowing contaminants to absorb solvent and dissolve into the solution. As solvents are used, their ability to neutralize acids lessens. While the common practice is to add new solvent to the aged solvent, a more efficient method is to analyze the solvent and replenish specific components. The expense of analysis will be offset by the savings in solvent for tanks of approximately 500 gallons or more; and

Other Improved Operating Practices which Result in Waste Reduction Include:

- Standardize the solvent used to allow for recycling,

- Control the amount of heat supplied to vapor degreasers to minimize vapor escape,

- Avoid spraying parts above the vapor zone or cooling jackets,

- Avoid solvent vapor "pump-out" caused by rapid parts-basket insertion and withdrawal,

- Avoid liquid solvent "drag-out" by allowing parts to come to vapor temperature before withdrawing the parts basket;

B. Vapor Degreaser Modifications for Waste Reduction (S)

- Install lids/silhouettes on tanks -- all tanks should be covered when not in use.
Covers that can be used even during the cleaning process (known as "silhouette entries") are available and allow for an even greater reduction in vapor loss. All covers should be designed to slide horizontally over the top of the tank, since this disturbs the vapor zone less than hinged covers;

- **Increase the freeboard space on tanks** -- an increased freeboard has been proven to decrease emissions. Early degreasers had a freeboard equal to one-half the tank width. When the U. S. EPA in the mid-1970s recommended a 75% freeboard, emissions were decreased up to 46%. Increasing the freeboard to 100% can provide an additional 39% reduction where air turbulence is present; and

- **Install freeboard chillers in addition to cooling jackets** -- a second set of refrigerated coils is installed above the condenser coils. These coils chill the air above the vapor zone and create a second barrier to vapor loss. Reductions in solvent use of up to 60% have been realized. However, water contamination of the solvent can occur due to frost on the coils, so a water collector is also necessary.

II. Solvent Soak Tank or Parts-Cleaning Sink Solvent Wastes

A. Better Operating Procedures

There used to be a washtub or soak tank in almost every maintenance, machine or repair shop. It was filled with a petroleum solvent such as "Varsol", mineral spirits, or the like. The historical procedure is to use the solvent and a brush or rag to wash grease, oil, dirt, and other soils from parts, dies, hands, etc. When the solvent "looks dirty", someone pours it out into a waste drum (Everybody now realizes that it is illegal to take it out back and pour it along the fence as weed killer, don't they?) and replaces it with clean solvent. If the company is "modern and progressive", the washtub or soak tank may well have been replaced by a parts-cleaning sink which is serviced by a congenial routeman who comes around every few weeks, removes the solvent container, replaces it with another filled with clean solvent, and leaves behind a properly-completed hazardous waste manifest.

A surprising number of companies have found themselves in the category of LQG simply on the strength of the accumulated amount of solvent waste manifested from such operations. In most instances, this is unnecessary -- a return to SQG or even non-generator status can probably be achieved through procedure changes. Some options are:

- **Assume control of the "change-out" schedule** instead of leaving it to the parts-sink vendor. The replacement schedule is set for the convenience of the routeman, (and possibly to ensure adequate billings on the route), not to get maximum use from the solvent before replacement. Many users have found that there are no cleaning problems even when the period between replacements is stretched out to three times that recommended by the vendor. Some have installed timers to record the time the sink is in use, basing solvent replacement on actual hours of use.
• Consolidate cold cleaning operations into a centralized vapor degreasing operation.

• Locate cold cleaning tanks away from heat sources, keeping vaporization levels at a minimum.

• Keep soak tanks covered when not in use to minimize evaporation.

• Use multi-stage cleaning. If a washtub is replaced with a three-compartment sink where solvent overflows from compartment to compartment, counter-current to parts flow, the solvent usage can be reduced 75% to 80%. Dirty parts are scrubbed in the dirtiest solvent, then rinsed in less dirty solvent, and finally quickly sprayed off with clean solvent. The dirty solvent that overflows from the last compartment will equal the volume used in the final spray rinse.

B. Substitute a high-flash, "unlisted" solvent for the hazardous one.

Some spent solvents used for metal cleaning (e.g., mineral spirits, petroleum naphtha) fall under regulation as hazardous wastes solely because of the ignitability characteristic, defined as having a flash point lower than 140°F. Others (e.g., toluene, methyl ethyl ketone, methyl chloroform) are "listed" hazardous wastes, because they are found in the lists of solvents in the definitions of F001-F005 wastes.

If the required cleaning job can be done with another solvent which is not included in those definitions, then the spent solvent will not be a hazardous waste unless it has become contaminated with some toxic material in the course of use. In most applications in the fabricated metal products industry, this is rather unlikely to occur. Most vendors can now supply cleaning solvents formulated so as to avoid being classified a hazardous waste when spent. Examples are petroleum products prepared so that the flash point is well above 140°F, bearing names such as "Solvent 140", "Exxon Aromatic 150", etc.

C. Substitute water-borne cleaning agents for the solvent.

Newly developed synthetic detergents and compounded cleaners have been successfully used to replace solvents for general in-shop cleaning. This eliminates solvent wastes and removes a fire hazard from the workplace. If the cleaning operation is a production operation, a number of vendors now supply both equipment and formulated detergent preparations which can exceed the performance of most solvent operations.

One of the objections frequently voiced to these systems is that parts cleaned in them rust quickly. Although rusting is a good indication that the cleaning has been extremely effective, suppliers of cleaning compounds can supply rust inhibiting compounds to avoid this problem.
Another barrier has been that the aqueous solutions require more "elbow grease" than the solvent cleaners to remove heavy soils. It's as if you tried to wash all your dishes in cold water. To meet this objection, there are now a number of parts-cleaning sinks available which keep the solution warm, greatly enhancing degreasing ability, and some are equipped with high-pressure sprays or violent agitation so that extremely hot solutions can be used without exposing the operator to scalding hazards. Some have oil skimmers to keep the surface clear of oil, and/or circulating filtration systems to continuously remove dirt and other particulate matter. With those features, the need for solution replacement is greatly reduced.

III. Paint-Related Wastes

A. Reduce Equipment Cleanup Solvent Wastes through Improved Operating Practices

Solvent is used to flush painting equipment for two purposes: to prevent the paint from drying, curing or hardening while not in use, thus plugging hoses, tubes, orifices etc., and to remove paint of one color and allow change to another color.

This occurs both in the area where paints are prepared (the paint kitchen), and at the point of application. Some ways in which the solvent wasted can be reduced are:

- Minimize color changes by scheduling painting operations for the longest possible runs on each color,
- Minimize equipment cleanouts by dedicating equipment and piping to a specific color,
- Shorten the distance between the paint supply and the application device to reduce solvent required for each flush,
- Save flushout solvent, decant after settling, and re-use it several times or use it as thinner,
- Segregate flushout solvent according to color and use it as thinner in paint of the same color,
- Invest in a gun-cleaning station which returns the solvent to a reservoir for re-use.

B. Reduce Solvent Emissions to the Atmosphere from Painting Operations

A solvent waste which is seldom recognized in waste accounting is the solvent which serves as a carrier for the resins and pigments during application. Yet most paint "dries" by evaporating solvents which are then lost to the atmosphere. Most spray application
methods have inherently low transfer efficiency, which is the percent of the paint passed through the application device which actually adheres to the surface of the object being painted. Also, an operator using improper application technique can reduce transfer efficiency even further. As a result of these factors, it is not unusual for industrial spray-painting operations to deposit one-fourth or less of the paint sprayed onto the item painted. The other three-fourths of the paint misses the item and is a total waste, and all the solvent contained in the paint sprayed is emitted as an air pollutant.

One obvious waste reduction option is to improve transfer efficiency. Some ways to do this are:

- Train operators in proper spray application techniques,
- Re-arrange parts racking to maximize profile facing operator,
- Provide spray apparatus such as high volume-low pressure, airless, air-assisted airless or electrostatic equipment, all of which have inherently greater transfer efficiency than conventional air-atomized spray,
- Adjust spray booth air flow to curb excessive draft or stray air currents,
- Use robotic applicators on production lines where identical items are being painted.

Another way to reduce solvent losses to the atmosphere is to reduce the quantity of solvent in the paint.

Paint vendors now furnish paints with varying levels of volatile organic compounds (usually called VOC's). This is a measure of the amount of solvent used to formulate the paint, and is usually expressed as "pounds of VOC's per gallon". Thus, a gallon of paint with 6 lbs./gal of VOC's would contain twice as much solvent as would one with 3 lbs./gal of VOC's. Naturally, the low-VOC paint will be thicker and contain more pigment and film-forming ingredients than the other. In order to use a low-VOC paint and get the accustomed dry-film thickness and proper flow characteristics, application techniques must be modified. Care must be taken that the paint is not applied too thickly, thus wasting paint and causing drying problems. Paint and painting equipment vendors can provide valuable technical assistance. One adjustment often made is to install in-line heaters which warm the paint just before application, thinning it so it handles in a manner similar to paints with higher VOC's.

The logical extension of the idea of reducing solvent content is to move from solvent-based paints to water-based paint. Improved resins and formulation technology have made it entirely possible to make water-borne coatings which are every bit as durable and attractive as traditional solvent-based ones.
A variation on this idea, which may be practical in some instances is to move to powder coatings, electrodeposited coatings or autophoretic coatings, which contain no solvents at all. Full details will be found in the references listed in the Bibliography.

IV. Spent Solvents from Any Source

Spent solvents are those which, by virtue of having been used for cleaning, are contaminated with oils, grease, paint resins and pigments to the extent that they can no longer remove the soils from the items to be cleaned. Once they reach that state, the common procedure is to dispose of them, usually as hazardous waste.

There are some options which may be worth considering before taking this step:

A. Find A Use for the Spent Solvent

- Some fabricating shops which do a large amount of grinding or lapping have found that spent hydrocarbon solvent which has been used for removing oil and grease can be passed through a filter to remove solid suspended matter and used as a lubricant on a grinder or lapping machine.

- If the solvent is of the high-flash hydrocarbon type, it can be burned on-site in a used-oil burner for water heating or space heating. (See section on Used Oils).

B. Recover the Solvent with an On-Site Still

- A number of manufacturers can supply small solvent recovery stills, some of which process batches as small as five gallons, on a cycle which requires about six hours. Other stills will process as much as 30 gallons. With appropriate controls, no attention is required except to charge and start the unit, and remove the still bottoms. If the solvent to be recovered is flammable, the unit should be equipped with explosion-proof controls. It is also desirable to isolate the still from other operations.

The still bottoms will contain all the non-volatile contaminants, along with some of the solvents. The bottoms from spent solvents which would be F001-F005 hazardous wastes will still be a hazardous waste, and should also be tested to determine whether they exhibit ignitability or TCLP toxicity.

- At least one user of a still to recover paint thinner was able to work with his paint supplier and formulate an inexpensive undercoat product with superior protective properties, using bottoms from the recovery still as a raw material.

CAUTION: These devices are not truly "distillation systems", but are simple evaporators. They are not capable of separating one volatile solvent from another,
but can only evaporate volatile materials (including water) from such non-volatiles as grease, oil and dirt. If you have wet or mixed solvents, the distillate may be of no use to you, making purchase of a still inadvisable. If there is any doubt, technical assistance should be obtained.

USED OILS

A. Reclaim and Reuse Lubricating and Hydraulic Oils

Any operation which uses large quantities of hydraulic oil or lubricating oils as gear oil, compressor oil, etc. probably has a well-established drain/flush/replace cycle for those fluids. The used fluid probably is contaminated with fine particulate matter and water or other volatile materials like transmission fluids, diesel fuel, or solvents. It is a possibility that some additives have been depleted.

Nevertheless, the oil itself is perfectly good and could be reused if properly reclaimed. There is a service which will bring a trailer-mounted reclaiming system to plant sites, remove particulates and volatiles from used lubricating and hydraulic fluids, and replace additives to return the oil to original performance specifications. The processing charge varies somewhat depending on volume to be reclaimed and treatment needed, but the usual result is to reclaim these oils at about one-half to two-thirds the cost of replacement. In addition, disposal costs are completely eliminated.

B. Recycle Oil through Off-Site Reclaimers or Fuel Blenders

There are many companies which will remove used oils from a plant site and process them in their own facilities, either into fuels, or in some instances re-refine the oil and return it to the market. Whether these companies charge for the service or pay for the oil depends largely on market factors, but in recent years a charge of ten to thirty cents per gallon has been the rule. It is important that the generator prevent contamination with water to preserve whatever value the oil may have. It is also imperative that the oil not be contaminated with any characteristic or listed hazardous waste.

Under a recent RCRA ruling (described earlier), off-site reclaimers who pick up used oil and transport it from plant sites should be required to demonstrate that they hold an EPA Hazardous Waste Transporter’s permit.

C. Use Waste Oil for On-site Space and Water Heating

A number of equipment companies (see Appendix) have recognized the value of used oils as a fuel for space- and water-heating, and have developed and obtained approval of systems which use oil which would otherwise be disposed of to replace heating oil or natural gas. The burners are designed to be trouble-free and to be able to handle sludgy, somewhat wet oils, making it possible to use waste oils from many sources.
This option has been particularly interesting to operations where large openings, heavy ventilation requirements or heavy indoor/outdoor traffic make space heating extremely wasteful of heat. Some vendors have designed used-oil burning systems for water heating, which helps relieve the seasonal utilization pattern inherent in space-heating.

D. **Eliminate Oil-Soaked Clay from the Waste Stream and Recover Oil, Too!**

Now that a "clamp-down" on disposal of oil-soaked clay absorbent is under way, it behooves those who have been wastefully using this material to look for a better way. One of the options which is gaining favor is to use fiber-filled "socks" or "pigs" around areas or machines where oil leaks are found. A number of fiber materials share the property of being attractive to oil, but repellent to water. This means that once they soak up oil, water will displace little or none of it, making the material safe for landfill disposal. They also are usually amenable to multiple re-uses, by squeezing out the oil. Because most of those materials are more expensive in first cost than the clay, the ability to re-use them is an important factor. Several suppliers now offer a hand-operated double-roll wringer which can be mounted on a collection drum to recover the oil, or at least recycle it into your other used oils. Fibers which have been used are polypropylene, natural peat, and various types of cellulose fiber products. The peat and some of the cellulose products are bagged in loose form for use in the same manner as oil-absorbent clay granules.

**METALWORKING FLUIDS**

If you use a "cutting oil" which is not extended with water for use, then all options given in the used oils section above apply to that material as well. The following options are specific to fluids which are used as machine-tool coolants, whether water-extended or not.

A. **Better Operating Procedures**

Many common practices in the shop contribute to loss and deterioration of machine coolants. Some practices that can be corrected with significant reduction in coolant fluid loss are:

- Disregard of splashing and sump leakage;
- Failure to recover coolant from turnings and swarf; and
- Dragout of coolant on finished parts.

B. **Proper Coolant Maintenance**

In the case of water-extended coolants, the main reason for discard is lack of maintenance of the mixture. Without maintenance, the life expectancy of coolants is quite short. With
a proper maintenance program, coolant life can be extended almost indefinitely.

Most coolant mixtures are discarded due to bacterial damage, not loss of effectiveness. A typical sequence of events is that tramp oil (such as may come from the machine’s gear case if seals leak) gets into the coolant, and floats on top. This excludes air and provides an ideal environment for growth of anaerobic bacteria. A dirty sump, warm and damp, provides ideal conditions for bacteria to multiply. The anaerobic bacteria produce a number of unpleasant metabolic wastes, among which are skin irritants, and hydrogen sulfide gas (the source of the smell of rotten eggs). At this point, operator complaints will result in the coolant being discarded.

Proper coolant maintenance consists of:

1. Regular or continuous removal of tramp oil and metal chips from the machine’s sump;

   Belt or disc skimmers are commonly used to continuously remove tramp oil from the coolant. A skimmer should be placed near the circulating pump, since the tramp oil scum usually drifts to that area. If excessive amounts of coolant are removed, the skimmer can be run intermittently by using a timer.

   Metal chips must be removed on a routine basis. They not only interfere with machining, they also provide sites for bacterial growth. Screens can be placed over the sump’s coolant entrances, or over exits from holding trays to prevent them from entering the sump. They should be periodically removed by raking or vacuuming out the sump. In some cases where built-in sumps are impossible to clean or skim, the openings have been sealed and external, accessible sumps have been added.

2. Control of bacterial growth, which requires;

   - Emptying the sump, raking out all solid matter, and steaming or chemical cleaning at the time old coolant is replaced.

   - Adding biocides, if needed.

   - Controlling the solution pH. This is very important and will reduce the need for biocides. A drop in pH indicates bacterial growth, so it should be checked frequently with pH paper or a pH meter and adjusted to the manufacturer’s recommended level with caustic soda solution.

   - Ensuring an oxygen-rich solution which will prevent growth of anaerobic bacteria. The rate of turnover should be as high as possible, or an aerator or agitator can be added.
3. Maintaining the coolant-to-water ratio at the recommended level. This ratio is critical to efficient coolant performance, but water evaporation is constantly occurring as the coolant is used. A relatively simple and inexpensive hand-held refractometer can be used to determine the ratio accurately.

These steps are inter-dependent, and they must be simultaneously followed if the program is to succeed.

C. For Extended Coolant Life, Use Mineral-free Water

Because tap water contains dissolved minerals, a build-up of mineral concentration takes place as water evaporates and is replaced with more tap water. These minerals can interfere with the chemical makeup of the emulsion, and many of the mineral salts are excellent nutrients for bacteria growth. Using mineral-free water for original dilution and continuing adjustment ensures the makeup of the solution remains at the optimum, and deprives bacteria of their "food." Simple, compact deionizing units can be piped into the water line where solutions are mixed, so that it is always available for make-up additions. Please note that, to be mineral-free, the water must be DEIONIZED, not softened. A separate "Zeolite" water softener DOES NOT make the water mineral-free.

More complete details and sources of information may be found in the articles listed in the Bibliography.

WASTEWATERS

Reduction of wastewater volume has traditionally been given a low priority, what with the availability and low cost of water. However, wastewater being discharged to sewers or surface waters is increasingly regulated, and sewer fees now often exceed the cost of the water, so attention should be paid to source reduction, re-use and recycling options.

1. Wastewater from Cleaning Systems

Some options which can reduce the quantity of wastewater generated in cleaning operations include:

- Use countercurrent water flow. That is, instead of using fresh water for each rinse stage and for make-up in the detergent solution, you introduce fresh water at the final rinse, then collect it and move it counter to parts flow, using it finally as make-up water to replace evaporation losses in the detergent solution. To avoid mineral build-up, it is usually necessary to arrange a continuous overflow, or even better, to use demineralized (deionized) water as the final rinse.

- Add filtration devices and oil skimmers to cleaning and stripping baths to remove solid matter and oils, thus avoiding the necessity for periodic draining and
Save acidic wastewater from pickling operations and use it to neutralize exhausted alkaline cleaning or stripping solutions.

If detergent solution is contaminated with oils, use skimmers followed by ultrafiltration to remove oil and return detergent solution for re-use instead of discarding it.

Use polymer type coagulants to maintain the water in water-curtain spray booths relatively free of paint solids, reducing the necessity for replacement.

Use algaecides and/or fungicides to prevent microorganism growth in cooling tower water thus extending the replacement cycle.

Do an in-depth evaluation of boiler-water treatment and boiler maintenance procedures to minimize blowdown volume.

Where electroplating or anodizing is done in-house, follow specific waste-reduction practices which can drastically reduce both the volume of wastewater and the amount of treatment sludge generated.

This is too complex a subject to be treated in this manual, but considerable detail is available in the several references found in the bibliography. However, the one improvement in operating practice which will yield the greatest results is to do everything possible to prevent or reduce dragout of plating solution into rinse waters. Examples of such practices are:

- Allow adequate drain/drip time to remove plating solution before parts enter rinse tanks,
- Use proper parts racking to promote fast and complete drainage,
- Where practical, use air knives or make-up water spray to strip plating solution off parts while still over the plating tank,
- Install aprons or "drag-out tanks" to return drippage to plating solution tanks and prevent loss to the floor drains,
- Use atmospheric evaporators to concentrate rinsewater for use as plating solution make-up.
SLUDGES

I. Paint-Related Sludges

Paint-related sludges are generated by the same operations which contribute to solvent losses and VOC emissions. Therefore, options which reduce solvent waste will also reduce paint-related sludges. For instance:

- Increasing transfer efficiency will reduce the amount of paint which coats booths, or is trapped by water curtains or booth filters, and
- Reducing the amount of cleanup solvent will reduce the amount of still bottoms generated.

In addition, a number of companies have now found it practical to collect paint solids and solvents which might otherwise be discarded, and have their coatings suppliers recycle them into new paints or undercoats.

Because sludges from solvent-based paints are almost certainly hazardous wastes, generation of hazardous sludges can sometimes be eliminated by switching over to:

- Water-borne paints,
- Powder coatings,
- Electrodeposited coatings, or
- Autophoretic coatings.

II. Grinding Sludges

Grinding swarf usually represents a loss of both machine coolant and metal values. Sometimes it is possible to drain enough liquid out of it to allow landfill disposal, and some plants have actually drained grinding swarf dry enough that their scrap metal dealer allows them to include the solids in their scrap metal trailer.

A more positive approach is to use a machine which is available to press almost all the liquids out for re-use, and deliver the solids as a hard, compact "briquette" which has definite scrap metal acceptance (See Appendix).

III. Plating Sludges

The two factors most important in reducing electroplating sludge generation are:

- Those practices which prevent drag-out of plating solution from ending up in the effluent to the wastewater treatment plant (See the section on wastewaters), and
- Those practices which ensure that wastewater from other sources within the
plant are not intermixed with plating wastewater prior to treatment. Any dissolved metallic salts in those streams would become a plating sludge and have to be handled as such.

Sludge dryers have proved quite cost-effective in reducing both the weight and volume of plating sludge. Costs of transportation and of disposal are usually both reduced substantially. See the Appendix for sources of information and technical assistance.

**CORROSIVE WASTES**

I. **Spent Pickling Acids**

Spent pickling acids are generated because the metal content has reached a level where the acid no longer effectively performs the intended function of removing rust.

- There is little to be done to increase the life of a pickling solution, except to establish procedures to ensure that the material being pickled remains in the bath only the amount of time required to de-rust. Any time beyond this simply allows the acid to dissolve good metal, unnecessarily consuming base metal while at the same time depleting the bath.

- A more effective approach would be to avoid the need for pickling, or at least to minimize the amount of rust by protecting metal from the elements, by storing it under cover, or by applying rust preventatives before storage.

- Mechanical cleaning methods have successfully replaced acid pickling in some plants. Blasting with plastic beads, glass, steel shot, or even sponge particles are some methods in use. Some users of wire or rod have installed abrasive cleaning machines which remove rust and scale as the material is un-reeled.

II. **Spent Alkaline Cleaning Solutions**

Proper maintenance of alkaline cleaning baths can extend the bath’s life many times. Things which are helpful are:

- Filter the bath continuously to remove suspended solids before a sludge develops at the bottom of the vat.

- Analyze the bath frequently and adjust the pH, solids content, etc. to the original levels by adding more alkali or detergent.

- To prevent a build-up of unwanted minerals, prepare the solution with demineralized water, and use only demineralized water for make-up. (See the section above on sludges).
III. Discarded Molten-Bath Cleaning Mixtures

It should be unnecessary to discard a complete charge of a heat-treating or cleaning salt mixture. Maintenance of the bath is the key. The impurities which do not volatilize out of the bath usually appear as a scum on the surface.

» Constant attention to the skimming operation can greatly reduce the amount wasted. If skimming is done regularly or continuously, the small amount of waste can sometimes be discarded by dissolving in wastewater which is to be treated as part of the pH adjustment process.

» Care in operation or design of parts racks can prevent the parts from falling off and accumulating in the bottom of the bath, which can make it necessary to remove the salts and clean out the vat.

IV. Recycling or Re-use Options

- Because these materials have acid or alkaline properties, see if there is some place in your operation they can be used instead of a purchased acid or alkali.

- Spent pickle liquor is sometimes in demand as a source of iron in making agricultural chemicals. There are also recovery systems available to crystallize the iron salt from the pickle liquor, returning the acid for further use.

- List the spent material on a waste exchange. They may have value for others.

METAL WASTES

Scrap metal is inevitable, but far too much is generated unnecessarily. The only way to approach this is by a systematic study of metals utilization in the plant. The study should determine the amount of scrap produced, the sources, and the reasons for generation at each source. Some possible reasons for unnecessary metal scrap, all of which are subject to minimization efforts, are:

» Inefficient layout for cutting, stamping, and similar operations,

» Poor scheduling, causing short runs or excessive over-runs,

» Purchase of coils or sheets in sizes not ideal for the intended operation,

» Worn or poorly adjusted machines which make excessive tolerances in layout necessary,

» Inordinate start-up and initial adjustment losses.
Excessive number of rejected parts -- this can be a machine problem, an operator problem, or both. Careful study of such situations may be necessary to pinpoint the needed corrective action.

Sometimes parts can be redesigned to enable increased utilization efficiencies. This factor should certainly be taken into account as new products are designed.

Once some degree of control has been established, continuous tracking of scrap rates for each machine on each shift can quickly alert management if a problem is developing.

PACKAGING WASTES

Most packaging wastes found in a metal fabricating shop are a result of nothing which has taken place in the manufacturing operation. Rather, they arrived in the plant along with the materials and supplies used in manufacturing. Regardless of their origin, once in your plant they must be discarded, recycled, or otherwise disposed of. As hauling and tipping fees for solid waste increase, this becomes a significant financial burden. Recent site assessments have revealed single plants bearing a waste management and disposal burden from $250,000 to over $500,000 annually, most of it due to packaging wastes.

The first, and most effective, source reduction measure which should be taken is to determine whether all this material is really necessary, then arrange with the suppliers to eliminate all that can be eliminated without jeopardizing the "as received" quality of the products.

The next is to determine how much of the material can be re-used, either in the plant, or as packaging for outbound material.

Third, dispose of as much of the excess as possible through recyclers or waste exchange.

Finally, all the rest must be disposed of, usually into a landfill.

Some options which may be of help in reducing specific types of packaging wastes follow.

WARNING: Many ingenuous schemes to reduce packaging waste have to be discarded for economic reasons. For example, returnable containers may not be practical because of the cost of shipping them back. Be sure you make a complete financial analysis before committing.

Wood Wastes

Arrange for suppliers to ship you their goods only on pallets which you will be able to use for outbound shipments. Unless you are in a single-supplier situation, this essentially eliminates inbound "throwaway" pallets.
Have suppliers who ship on heavy skids, or in wooden boxes take them back for re-use.

Enter into dialog with suppliers to devise multi-trip packaging such as collapsible wire or plastic boxes, plastic pallets, special racks, etc.

**Paper Products Wastes**

» Have suppliers cease using composite (such as plastic-coated paper) materials, replacing them with recyclable materials such as plastic stretch wrap.

» Have suppliers supply corrugated cardboard cartons heavy enough that the usual pallet, overwrap and/or strapping can be dispensed with. If these are designed to be knocked down, they may be returned for re-use. If return freight is prohibitive, maybe they can be used to ship your products. Failing all else, the cardboard is recyclable.

» Don’t allow paper and cardboard to become contaminated with oil, or mixed with non-recyclable material. Only relatively clean material has recycling value.

» Many fibre drums can be eliminated by purchasing cleaning compounds, drawing-die lubricants, or other powdered materials in 1 cubic yard returnable "super-sacks".

**Metal Packaging Wastes**

Since there is already a scrap metal recycling program in all metal fabricating shops, most metal packaging wastes can go directly into the proper scrap metal hopper.

» Empty steel cans, pails and drums are acceptable as scrap steel, but dealers may insist they be crushed, deheaded, or some other measure be taken to ensure they are and will remain empty.

» Steel strapping is usually accepted, but may have to be cut into short lengths.

» Steel 55-gallon drums should be eliminated to the extent possible by such measures as buying solvents and chemicals in returnable drums, buying in returnable 6-drum (330 gallon) tote bins, or even in bulk with storage in on-site tanks.

**Plastic Packaging Wastes**

Although plastic materials are recyclable in theory, markets are poorly defined. If plastics are a disposal problem, source reduction measures directed at suppliers may be the only effective route.
GENERAL NOTES ON RECYCLING

In a plant environment, recycling will be an effective option only if there is real employee involvement. To accomplish that involvement, there must be training, awareness that involvement is expected from top management downward, constant reminders, and incentives.

In general, if any two materials become mixed together, the opportunity for recycling is compromised. Therefore it is important that employees be educated as to what is permissible and what is not. For example, one sheet of carbon paper in a bale of office waste paper can be cause for the recycler to reject the entire bale. Stretch wrap with self-adhesive paper labels attached and cardboard with oil or paint on it are other examples of materials leading to rejection.

Composite materials such as plastic-coated paper, fiber glass reinforced plastic, etc. cannot be economically separated into their component parts, and are thus not recyclable. Use of such materials should be avoided if possible.

Supply of recyclable material usually far exceeds demand, but this situation varies from place to place. The only sure information on the market at your plant site for any material will come from someone who is willing to negotiate with you for it.

Do not expect to make money on recycling. If you can avoid paying for disposal, you are faring well under today’s recycling market.

The Appendix includes a list of companies involved in recycling materials from Tennessee sources. The list is subject to change almost daily. CIS will appreciate receiving any information you may have concerning companies which should be added to or deleted from the list.
BIBLIOGRAPHY

Publications

(Numerals in brackets refer to list of sources for ordering copies)

INCENTIVES FOR WASTE REDUCTION:

Huisengh, Donald, et al [3]

United States Environmental Protection Agency [6]

United States Environmental Protection Agency [6]

WASTE REDUCTION PROGRAMS:

Paige, William, editor [4]

United States Environmental Protection Agency [7]

United States Environmental Protection Agency [7]

Ventura County, California [1]
   Hazardous Waste Minimization Program Results and Case Studies. Ventura, CA: Ventura County Environmental Health Dept.; 1987

WASTE REDUCTION TECHNIQUES -- GENERAL:

Ventura County, California [1]

WASTE REDUCTION TECHNIQUES -- SPECIFIC:

ASTM Subcommittee on Vapor Degreasing

Dow Chemical USA, Chemicals & Metals Department
Economical and Efficient Vapor Degreasing; Dow Chemical Company, Midland, Michigan 48674; 1987

Hitchcock Publishing Company


California Department of Health Services. [1]


Tennessee Department of Economic and Community Development. [8]


Waste Reduction Resources Center for the Southeast
Solvents - The Alternatives; by Bob Carter; WRRC, P.O.Box 27687, Raleigh, NC 27611-7687; 1991 (Contains extensive lists of aqueous cleaners and equipment and their suppliers.)

American Machinist Magazine [9]
Recycling Coolant Reduces Costs; by George Schaffer, Sr. Editor; American Machinist Magazine, 1978

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SOURCES OF LISTED PUBLICATIONS:

[1] California Department of Health Services  
   Alternative Technology Section  
   Toxic Substance Control Division  
   P.O. Box 942732  
   Sacramento, CA 94234-7320  
   Telephone: 916-324-1807

   University of Pittsburgh Applied Research Center  
   320 William Pitt Way  
   Pittsburgh, PA 15238  
   Telephone: 412-826-5320

[3] Institute for Local Self-Reliance  
   2425 18th Street, NW  
   Washington, DC 20009  
   Telephone: 202-232-4108

   Solid and Hazardous Waste Management Branch  
   P.O. Box 2091  
   Raleigh, NC 27602  
   Telephone: 919-733-2178

   Industrial Extension Service  
   Raleigh, NC 27695-7902  
   Telephone: 919-737-2303

   401 M Street, SW (A-149C)  
   Washington, DC 20460  
   Telephone: 800-368-5888

[7] United States EPA  
   Center for Environmental Research Information  
   Publication Office  
   26 Martin Luther King Drive  
   Cincinnati, OH 45268  
   Telephone: 513-569-7562

[8] Tennessee Dept. of Economic and Community Development  
   7th Floor, 320 6th Avenue North  
   Nashville, TN 37219  
   Telephone: 615-741-1888

[9] Reprints of this and a number of related articles can be obtained from:  
   Master Chemical Company  
   P.O.Box 220  
   Perrysville, Ohio 43551  
   Telephone: 419-874-7902

Note: Some of the publications may be out of print. If unavailable, copies may be available from the CIS Waste Reduction Clearinghouse. The Clearinghouse may also have other publications which will be helpful in reducing your specific wastes. Contact Mr. Keith Ridley, Information Specialist, The University of Tennessee Center for Industrial Services, Suite 606, 226 Capitol Boulevard, Nashville, Tennessee 37219-1804.  
Telephone: 615-242-4816

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APPENDIX

I. Selected Vendors

SOLVENT RECOVERY STILLS

Acra Electric Corporation
3801 N. 25th Ave.
Schiller Park, IL 60176

ARTECH, Inc.
1221 East Houston
Broken Arrow, OK 74012

Artisan Industries, Inc.
73 Pond Street
Waltham, MA 02254

B/R Instrumental Corp.
P.O.Box 7
Pasadena, MD 21122

Baron-Blakeslee
2001 N. Janice Avenue
Melrose, Park IL 60160

Branson Cleaning Equip. Co.
Post Office Box 768
1 Parret Drive
Shelton, CT 06484

Brighton Corporation
11861 Mosteller Road
Cincinnati,OH 45241

Ceilcote/APC Division
Master Builder, Inc.
140 Sheldon Road
Berea, Ohio 44017

Corning Process Systems
Corning Glass Works
Big Flats Plant
Big Flats, NY 14814

Crest Ultrasonic Corp.
Scotch Road
Mercer County Airport
Trenton, NJ 08628

Detrex Corporation
Industrial Equipment Division
4000 Town Center
Southfield, MI 48075

Distillation Environmental Systems
525 Boulevard
Kenilworth, NJ 07033

Eaton Corporation
Process Control Components
1199 S. Chillicothe Rd.
Aurora, OH 44202

Ecology Equipment, Inc.
4162 Library Road
Pittsburgh, PA 15234

Finish Engineering Co.
921 Greengarden Road
Erie, PA 16501-1591

Hoyt Corporation
Forge Road
Westport, MA 02790-0217

HydroTek, Inc.
8501 W. 191st Street
Units 42 & 43
Mokena, IL 60448

Interel Corporation
P.O.Box 4676
Englewood, CO 80155

Kleen-Flo Company
15151 Technology Drive
Eden Prairie, MN 55344

Lenan Corp. (Recyclit)
P.O.Box 1017
Janesville, WI 53547

LUWA Corporation
Process Division
P.O.Box 16348
Charlotte, NC 28297

7334 N. Clark Street
Chicago, IL 60626

Progressive Recovery, Inc.
700 Industrial Drive
Dupo, IL 62239

Ramco Equipment Corp.
32-34 Montgomery St.
Hillside, NJ 07205

Recyclene Systems
405 Eccles Avenue
So. San Francisco, CA 94080

Siva International, Inc.
c/o J. B. Systems
P.O.Box 11000
Rock Hill, SC 29731

Vaco-Solv Chicago, Inc.
P.O.Box 1544
Barrington, IL 60011

VARA International, Inc.
VARA Corporation Center
1201 19th Place
Vero Beach, FL 32960
ON-SITE SOLVENT RECOVERY SERVICES

Smiseth Corporation
Post Office Box 1424
Murfreesboro, TN 37133

Solvent Reclaimers
Route 3, Box 323
Murfreesboro, TN 37219

First Source
340 Avebury Court
Alpharetta, GA 30202

USED OIL BURNERS

Clean Burn, Inc.
83 South Groffdale Road
Leola, PA 17540
800-331-0183

Hooter, Ltd.
P.O.Box 19
Fombell, PA 16123
412-758-4561

Kroll Heating Alternatives, Inc.
P.O.Box 6
Manhasset, NY 11030
516-456-3475

Lenan Corporation**
615 North Parker Drive
Janesville, WI 53545
608-752-1601

Reznor Waste Oil Heaters
Telephone 800-695-1901
Ask for Catalog WOHUS 5/92

Robert Sun Company*
240 Great Circle Road, #344
Nashville, TN 37228
615-251-0680

* Water-heating capabilities available
** Both water-heating and multiple-waste fuel capabilities indicated.

PARTS CLEANERS

ADF Systems, Ltd.
1301 19th Street N.
P.O.Box 278
Humboldt, Iowa 50548
515-332-5400

Better Engineering Mfg., Inc.
7101 Belair Road
Baltimore, MD 21206
800-638-3380

Bowden Industries, Inc.
1004 Oster Drive NW
Huntsville, AL 35816
800-553-3637

Kleer-Flo Company
15151 Technology Drive
Eden Prairie, MN 55344
800-328-7942

J. S. Mannor Machine Corp.
427 East Judd St.
Woodstock, IL 60098
815-338-8700

Kleen Flo Corp. 
P.O.Box 1419
Elgin, IL 60120
Local Offices Everywhere

Zep Manufacturing Company
P.O.Box 2015
Atlanta, GA 30301
404-352-1680
SLUDGE DRYERS AND COMPACTING EQUIPMENT

JWI, Incorporated
2155 112th Avenue
Holland, MI 49424
616-772-9011
(Dryer)

Eco Systems & Design, Inc.
Rt. 9, Box 539 Belmont Drive
McMinnville, TN 37110
800-332-8426
(Recovery Press)

HIGH-FLASH CLEANING SOLVENTS

Chemex Industrial Chemicals
1357 Heistan Place
Memphis, TN 38104
901-272-2431

CTC Industrial Services, Inc.
1827 Latham St.
Memphis, TN 38104
901-942-1212

Safety-Kleen Corp.
7217 Airways Road N.
Olive Branch, MS 38635
901-349-2842 (Memphis No.)

Cone Solvents
2064 Channel Avenue
Memphis, TN 38113
901-946-1638

Zep Manufacturing Company
P.O.Box 2015
Atlanta, GA 30301
404-362-1680

II. Waste Exchange Information

Maxie L. May
Southeast Waste Exchange
Urban Institute, UNC-Charlotte
Charlotte, NC 28233
704-547-4289

The exchange listed above is the only one known to be operating in this area at present. Efforts are under way, however, by Tennessee Department of Environment and Conservation’s Technical Assistance Department to establish one for Tennessee waste generators. For current information, call DeAnna Fry at 615-532-0074.

III. Sources of Free, Personal, Hands-On Technical Assistance

The University of Tennessee’s Center for Industrial Services -- Telephone Keith Ridley at 615-242-4816

Waste Reduction Resource Center for the Southeast -- Telephone 800-476-8686

IV. List of Available Recycling Resources

For the most current recycling information available, contact the Tennessee Recycling Coalition, P.O. Box 23346, Nashville, TN 37202, or DeAnna Moore Fry, Tennessee Department of Environment, Div. of Solid Waste Assistance, Recycling Section, 615-532-0074.

GLASS RECYCLERS

Bassichis Co., P.O.Box 211, Ashland City 37015 615-792-5417

Buffalo River Services, P.O.Box 655, Waynesboro 38485 615-722-5401
Dixie Recycling Co., 2747 Jackson Ave., Memphis 38108-3319 (Brooks Gold) 901-324-1495
RSI - Recycling Services, Inc., P.O.Box 271, Carthage 37030 615-374-3490
Springfield Recycle Center, Box 535, Russelville, KY 42276 615-384-2918
Steiner-Liff Co., 701 S. 1st, Nashville, TN (John Bow) 615-271-3383

PLASTICS RECYCLERS

BFI Recyclery, Inc., 1245 Morehead, Memphis 38107 (George Sykes) 901-525-0276
Pad Warehouse, 2640 Faxon, Memphis 38112 (Furniture Foam) (Judi Long) 901-327-9506
Deka Plastics, Inc., Greenfield, TN 38230 (Industrial Scrap) 901-235-3347
Jeanell Foam (Residue of TN, Inc.), P.O.Box 25, Bradford 38316 (Furniture Foam) 901-742-3925
Jeanell Sales Corp., P.O.Box 537, Sharon, TN 38255 (Plastic Lumber Mfgr.) 901-456-2681
LinPac, 5725 Commerce Blvd., Morristown, TN 37814-1049 (Stretch Wrap) (Larry Crabtree) 615-586-8917
Plastech Systems, 5586 Old Hwy 78, Memphis 38118 (Sheet & Film) (Lester Foreman) 901-366-4848
Plastic Technologies, Inc., Hwy 77, P.O.Box 7, Yorkville 38389
Steiner-Liff Co., 701 S. 1st, Nashville, TN (John Bow) 615-271-3383
TIDI Waste Systems, P.O.Box 1894, Morristown, TN 37816 (Stretch Wrap) (Mickey Beesley) 615-581-5655
White Star Mfg. Co., P.O.Box 1511, Smyrna 37167 615-355-3010

For the nearest Expanded Polystyrene Foam (EPS) packaging material collection center, call 800-944-8448.

WOODEN PALLET RECYCLERS

BFI Recyclery, Inc., 1245 Morehead, Memphis 38107 (George Sykes) 901-525-0276
Jack Daniel Distillery, Lynchburg 37352 (Doug Clark) (Also uses other wood wastes) 615-759-4221
The Pallet Factory, 821 Vance, Memphis, 38103 901-526-8055
Pallet Supply Co., Inc., 587 Hernando, Memphis, 38103 901-529-0051
Reliable Pallets, Jackson (Vernon Lawrence) 901-424-9809
T-Tech, Incorporated, P.O.Box 190, Humboldt 38343 (Bob Hammons) 901-784-8558

POST-CONSUMER GOODS RECYCLERS
(Packaged Goods, Out-dated/Off-Spec, etc.)

BFI Recyclery, Inc., 1245 Morehead, Memphis 38107 (George Sykes) 901-525-0276
Recycle, Incorporated, Route 2, Box 120, Bells 38006 (Gerry Rains)
(Evans Drive, Hwy. 412 Industrial Park) 901-663-3900
## Textile Materials Recyclers

Alpha Cellulose Corp., Lumberton, NC
Lafayette Cone Company, Hwy 27N, Lafayette, GA 30728  404-764-1089
OHCO, Inc., 4158 Robinson, Covington, GA 30209 (Bett Knight)  800-241-1008

## Paper

The following mills and companies are involved at some level in recycling paper or paper products. This compilation is not a complete listing, and does not indicate endorsement of any listee. Please contact the businesses for more information, because certain restrictions may apply (see comments following listings).

<table>
<thead>
<tr>
<th>Company</th>
<th>Address</th>
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<tbody>
<tr>
<td>Rock-Tenn</td>
<td>2900 Home Drive, Chattanooga, TN 37410</td>
<td>615-267-0097</td>
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<tr>
<td>BFI Recyclery, Inc.</td>
<td>1245 Morehead, Memphis, TN 38107</td>
<td>901-525-0276</td>
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<tr>
<td>Jefferson-Smurfit Corp.</td>
<td>1131 Agnes Place, Memphis, TN 38101</td>
<td>901-726-1600</td>
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<tr>
<td>Packaging Corp. of America</td>
<td>P.O. Box 33, Counce, TN 38326</td>
<td>901-689-5225</td>
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<td>BFI Recyclery, Inc.</td>
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<td>901-525-0276</td>
</tr>
<tr>
<td>Eco Services</td>
<td>9123 Pidgeon Roost Rd., Olive Branch, MS</td>
<td>901-521-8020</td>
</tr>
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<td>2900 Home Drive, Chattanooga, TN 37410</td>
<td>615-267-0097</td>
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<tr>
<td>Inland Container Corp.</td>
<td>P.O. Box 299, New Johnsonville, TN 37134</td>
<td>615-535-2161</td>
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## Cardboard and Corrugated Board

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<td>901-689-5225</td>
</tr>
<tr>
<td>Southern Paper Company</td>
<td>Rankin Road, Newport, TN 37821</td>
<td>615-623-8611</td>
</tr>
<tr>
<td>Eco Services</td>
<td>9123 Pidgeon Roost Rd., Olive Branch, MS</td>
<td>901-521-8020</td>
</tr>
<tr>
<td>Dixie Recycling, Inc.</td>
<td>2747 Jackson Avenue, Memphis, TN 38019</td>
<td>901-324-1495</td>
</tr>
<tr>
<td>Packaging Corp. of America</td>
<td>P.O. Box 33, Counce, TN 38326</td>
<td>901-689-5225</td>
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COMMENTS ON PAPER PRODUCTS

The purchase price of corrugated varies with the market, and has varied between $10 and $35 per ton in 1991-2. As for economic justification, it has been said that a generation rate of 10 to 15 tons per month would be required to make baler purchase pay off, even at the higher prices, if only the money received for cardboard is considered. If all disposal costs are considered (hauling cost, landfill tipping fees, etc., which are constantly increasing) are taken into account, that picture improves. If all paper wastes and the possibility of using the baler for materials such as stretch wrap or fabric scrap are included in the consideration, that should help too.

The following comments were obtained from the Memphis recycling program office of Jefferson Smurfit, a large paper products company. These impressions of the current situation are probably typical around the state.

Recyclers will either pick up for recycle or broker corrugated cardboard for someone else’s pick up from any plant site in Tennessee, but certain conditions apply. They have programs on several grades of waste paper, too. Apparently, there are so many variables in the waste paper business that each generating site is considered individually.

Any mixing of grades or including composites such as plastic-coated paper, etc. will make the material unacceptable. Segregation is the key to successful recycling of paper products. One possible exception to this is BFI’s office paper policy, which allows all types and grades of paper.

Cardboard must be baled into what is known as a “standard mill bale”. This is described as being 60 inches by 30 inches by 36 inches and having a minimum weight of 750 pounds. It should be clean and free of foreign matter - especially oil.

Generator must store the bales until a full truckload has accumulated. Indoor storage is not necessary, but bales must be protected from becoming soggy and located so as to be accessible for pick up. They may be stacked three high.

Some recyclers will provide a baler by direct sale or through a lease/purchase plan. Lease payments of about $300/month let the generator own the baler after two years.

For up-to-date information, contact any of the recyclers listed above.

WASTE OIL HANDLERS IN TENNESSEE

| AAA Industrial Maintenance Service | 901-774-8146 |
| 172 Kimbrough Place | CTC Industrial Services |
| Memphis, TN | 1827 Latham Street |
| 901-725-1109 | Memphis, TN 38106 |
| 901-942-1212 | Enterprise Oil |
| 2843 Harrison Pike | 728 Owl Hollow Road |
| Chattanooga, TN 37406 | Knoxville, TN 37923 |
| 615-622-7039 | 615-690-9751 |
| Able Energy Company, Inc. | Enterprise Waste Oil |
| 1245 Channel Avenue | White Wing Road |
| Memphis, TN 38113 | Lenoir City, TN 37771 |
| 901-942-1523 | 615-986-7972 |
| Bryson Environmental Services | Ferguson Harbor Service |
| 552 Rivergate Road | 340 Rockland Rd. |
| Memphis, TN 38109 | Hendersonville, TN 37075 |
| | 615-822-3295 |
| | Goins Waste Oil Co. |
| | 1606 E. 48th Street |
| | Chattanooga, TN 37407 |
| | 615-867-2216 |
| | H&H Oil Recovery Company |
| | Flatwoods Church Road |
| | Camden, TN 38320 |
| | 901-584-2043 |
| | Hurley’s LP Gas |
| | 1288 Arden Lane |
| | Morristown, TN 37813 |
| | 615-586-2392 |
MELAS RECYCLERS and RECOVERY FACILITIES

Scrap Metal Dealers

Lazarov Brothers
1166 North Seventh
Memphis, Tennessee 38107

Iskubits Metals
604 Marble Ave.
Memphis, Tennessee 38107

F. Perlman & Co., Inc.
Post Office Box 582
Memphis, Tennessee 38105

Southern Tin Compress Corp.
1270 N. Seventh
Memphis, Tennessee 38107

City Iron of Tennessee
29 E. Illinois Ave.
Memphis, Tennessee 38106

Ben Mogy & Son Co.
2530 Shasta Avenue
Memphis, Tennessee 38108

South Memphis Iron & Metal Company
2250 South Third St.
Memphis, Tennessee 38109

Airways Iron & Metal Co.
2105 E. Person Avenue
Memphis, Tennessee 38114

H. Blockman & Company
376 North Front St.
Memphis, Tennessee 38103

Hutcherson Scrap Co., Inc.
Post Office Box 218
Halls, Tennessee 38040

Sanitized Steel
Post Office Box 1217
Memphis, Tennessee 38101

Steiner-Liff Iron & Metal Co.
Post Office Box 1182
Nashville, Tennessee 37202

Ben Greenberg Co., Inc.
119 East Cedar
Dyersburg, Tennessee 38025-0647
901-285-4424

Tri-County Recycling
P.O.Box 217
Henry, Tennessee 38231
901-243-7302 (Al Cripe)
Precious Metals Recovery, Including Photographic Film and Solutions
American Silver Company
6167 S. Mt. Juliet Road
Hermitage, TN 37076
615-871-4301

Bowden Industries, Inc.
P.O.Box 913
Covington, Tennessee 38019
901-476-1813

Capital Silver Service
P.O.Box 683
Gallatin, Tennessee 37066
615-452-3574

Non-Ferrous Metals Recovery from Sludges, Filter Cakes, Liquids and Dusts
Horsehead Resource Development Co.
P.O.Box 5
Rockwood, Tennessee 37854
615-354-0955

RECONTEK, Inc.
28 East Yates, Newman, IL 61942
217-837-2407

C P Chemicals, ERS Division
One Parker Place
Fort Lee, NJ 07024
201-944-6020

Encycle, Inc.
5703 Cates Drive
Greensboro, NC 27410
919-299-2265

Smelters of Non-Ferrous Metals
Ross Metals, Inc.
P.O.Box 57
Rossville, TN 38066
901-853-7701

Wabash Alloys
P.O.Box 341
Dickson, TN 37055
615-446-0600

EMPTY LASER PRINTER & COPIER TONER CARTRIDGE RECYCLERS
American Laser Recycling Inc., 4646 Poplar Avenue, Memphis 38117 901-763-2286
PC Applications Consultants, Inc., 759 Cedar Brake Drive, Memphis 901-757-0810

LEAD-ACID BATTERY RECYCLERS
Battery Warehouse, 3251 Millbranch, Memphis, 38116 901-332-1521

SOUTHEAST WASTE EXCHANGE
The Southeast Waste Exchange (SEWE) is a non-profit information clearinghouse sponsored by the Urban Institute of the University of North Carolina at Charlotte. It was established to bring together industrial waste generators with potential users, and companies seeking waste management services with those who can provide them. SEWE publishes the Waste Watcher, a bi-monthly catalog, listing materials available or wanted, and products and services available. Materials available and materials wanted listings range from Acids to Plastics to Waxes.

Subscriptions to the Waste Watcher catalog are $25.00 per year, and waste exchange listings are coded so that only subscribers can use the service. For complete information call or write:

Maxie L. May
Southeast Waste Exchange
Urban Institute, UNC-Charlotte
Charlotte, NC 28233
Telephone: 704-547-4289
Fax: 704-547-3178
WRITING A WASTE REDUCTION PLAN

A Guide

Prepared for

Small Quantity Hazardous Waste Generators

in the

FABRICATED METAL PRODUCTS INDUSTRIES

(SIC Group 34)
WRITING A WASTE REDUCTION PLAN  
for a  
FABRICATED METAL PRODUCTS FACILITY  

Why Do We Need a Written Waste Reduction Plan?  

THE EASY ANSWER to that question is that the Hazardous Waste Reduction Act of 1990 requires it of all hazardous waste generators in Tennessee. The Act provides for civil penalties of up to $10,000 per day for failure to file, refusal to comply, or giving false information.  

BUT THE REAL ANSWER IS MUCH MORE COMPLEX!  

Here are some reasons you may be able to relate to:  

- Your company, when it generates hazardous wastes, assumes perpetual liability for any future damage those wastes may do to the environment, even long after you have "disposed" of them.  

- Furthermore, every time you prepare and sign the EPA-required hazardous waste manifest, you certify that you are making your best efforts to reduce hazardous waste generation. Having this plan in writing and making annual progress reports documents that certification.  

- Reducing the rate at which your facility generates hazardous wastes will correspondingly reduce employee exposure to materials which may be harmful to their health.  

- Managing, storing and disposing of wastes - hazardous or not - requires manpower, paperwork and several less obvious expenditures which make your operation that much less profitable.  

- The procedure involved in writing an effective waste reduction plan requires that every operation be carefully examined by a team of individuals with different priorities and viewpoints. The observations made and the questions asked, if followed up, are likely to result in improvements in productivity, quality and safety, as well as in waste reduction. This is an unforeseen bonus many companies have reaped.  

---  

1 The Tennessee Hazardous Waste Reduction Act of 1990 (TCA 68-46-301 et seq.) required large quantity generators to have the plan in place on January 1, 1992; small quantity generators must have a plan in place by January 1, 1994.
On top of all this, you will probably find that much of the waste is generated unnecessarily, and can be eliminated with a little effort, changes in procedures, and waste awareness training, thus improving profitability without significant expenditure.

Is Our Plan a Public Record, Available to Anyone Who Wants to See It?

No. Your plan (and your annual updates) remain on your premises. They must be available for inspection, but are not filed with the Solid Waste Control Board or any other State Agency. You report your progress to the State in your annual Hazardous Waste Activities Report. In that report, the information is coded to reveal only proportional data. The key to the code is contained only in your plan. [Section 311]

Are We Required to Make a 25% Reduction in Our Hazardous Waste?

Not necessarily. The 25% reduction before June 30, 1995 is a statewide reduction goal. Individual generators have no limits (top or bottom) set on the goals they set. Generators are expected to set goals which support Tennessee's policy that, "wherever economically and technically feasible, the generation of hazardous waste is to be prevented or reduced as expeditiously as possible". [Section 302(a)]

Does the Solid Waste Management Act of 1991 Also Require Us to Reduce Solid Waste Generated and Hauled to the Landfill?

No. This law requires no action by solid waste generators. But it does require counties and municipalities to provide the means by which solid waste landfilled and incinerated will be reduced 25% by December 31, 1995. What this really means is that industrial generators will eventually find disposal costs increasing rapidly, so that solid waste reduction will make greater economic sense each year that passes. For that reason, we recommend that, as long as you are writing a waste reduction plan, you include solid waste reduction. We suspect that many small quantity generators of hazardous waste will find more economic incentive for reducing solid waste than for hazardous waste.

How Do We Get Started on A Plan?

The key word in the title of the plan is "reduction". In order to plan how you are going to reduce waste, it is first necessary to know a great deal about your wastes. At the very least, you must know what your wastes are, and how much you generate now. The way to do this is to perform what has come to be known as a Waste Reduction Assessment.

Most companies agree that a team approach, where a team leader - or Cause Champion as he is sometimes called - has available for ideas and evaluation a broad base of talents and insights. For instance, who knows more about the process that generates the waste than the machine operator? Yet, persons who maintain the equipment often can throw light on
the causes of wasteful equipment performance. Those who specify and procure supplies
and raw materials and those who set and monitor quality standards can help identify
wasteful practices and propose methods of correcting them. Thus, the assessment team
should have the broadest possible make-up. Bringing in "outsiders" to take part is often a
great help, because they are not inhibited in asking "Why do it this way?", nor will they be
as likely as employees to suffer from the "sacred cow" and "if it ain't broke, don't fix it"
syndromes.

During an assessment, each waste stream will be identified, quantified and profiled. The
profile will include the operation or process which causes it to be generated, factors which
influence quantity, and all other relationships which can be uncovered between process and
waste stream. Once the wastes have been profiled, your opportunities for waste reduction
are defined. Remember, EVERY WASTE STREAM IS A WASTE REDUCTION
OPPORTUNITY!

The next step is to investigate options for reduction. Many proven techniques for reducing
wastes in a metal fabricating environment will be found in the manual entitled Waste
Reduction Assessment Manual for the Fabricated Metals Industry. Use the Manual and the
diagram on page 7 as a guide in doing the assessment.

Making a waste reduction assessment of an entire facility may require only a few manhours
of effort, or it may require several days of effort by a team. This will depend on the size
and diversity of the facility, but the following checklist should help the Cause Champion
to determine if it has been done thoroughly and correctly.

WASTE REDUCTION ASSESSMENT CHECKLIST

? Has a detailed flow diagram of the entire facility been prepared, showing all materials entering
and leaving, whether they are raw materials, products or waste streams?

✓ Facility Flow Diagram Prepared Yes [ ] No [ ]

? Has the flow diagram been examined and verified for accuracy by those whose activities or
processes generate the wastes?

✓ Flow Diagram Verified for Accuracy Yes [ ] No [ ]

? Have reliable measurements or best possible estimates been made of the amount of each
waste stream?

✓ Waste Streams Quantified Yes [ ] No [ ]

? Has each waste stream been characterized as to whether it is a hazardous waste, and the
reason for that classification (ignitable, corrosive, reactive, toxic, or listed) been determined?

✓ All Waste Streams Characterized Yes [ ] No [ ]
Have the best possible efforts been applied to determining the true cost of each waste stream?

✓ Costs of All Waste Streams Determined

✓ Have the assessment team determined whether improvement in operating procedures or other in-house practices (e.g., purchasing or inventory procedures) could reduce each waste stream?

✓ Improved Procedures Options Identified

✓ Have those streams which may be reduced or eliminated by substituting a different raw material in the process been identified? Have appropriate substitutes been suggested?

✓ Raw Material Substitution Options Identified

✓ Have those streams which can be reduced by making a process change been identified? Have appropriate changes been suggested?

✓ Process Modification Options Identified

✓ Have the waste streams been arranged in order of priority for reduction?

✓ Waste Reduction Opportunities Prioritized

✓ Are those options which require expenditure of funds being investigated for economic feasibility?

✓ Economic Feasibility Analysis Initiated

✓ Are those options where there is doubt about workability being evaluated for technical feasibility?

✓ Technical Feasibility Analysis Initiated

✓ Has a schedule for repeat assessments been established and published?

✓ Reassessment Schedule Established

What Should Our Waste Reduction Plan Include?

The Law Either Requires or Suggests the Following:

A. Suggested: [Section 305(f)]

- A preface, wherein you can relate such facts as (a) what had been done to reduce waste prior to writing the plan and (b) special circumstances which make it difficult to reduce certain wastes.
B. Required: [Section 305(a)(1 through 6)]

- A dated and signed written policy. This sets forth management’s support for implementation of the plan.

- A statement of the scope and objectives of the plan. Outlines the waste reduction goals and the means to be used to achieve them.

- A description of waste reduction options and a schedule for them to be implemented. The law requires these options to have been evaluated for technical and economic feasibility. To fulfill this requirement, a formal waste reduction assessment of the entire facility will have to be conducted.

- A description of a cost accounting system for wastes. This system is to ensure that such indirects as liability, compliance and oversight costs are taken into account as well as direct costs of materials and labor expended.

- A description of training programs. These programs are to be designed to promote employee awareness, and to fully involve all employees in both planning and implementation.

- A description of measures to be taken to ensure an ongoing effort. Waste reduction must be integrated into management’s long-term operating plan for the facility.

- The law allows the Solid Waste Control Board to require other information by regulation, and also prohibits it from requiring disclosure of proprietary information. As of this writing, no regulations with additional requirements have been promulgated. [Sección 305(a)(7)]

What Goes into Each Section of the Plan?

The remainder of this workbook will consist of information and aids for developing your plan, section by section. When you have worked your way to the end, you should have a plan that is tailor-made for your facility.

Your completed plan may resemble the plan for the fictitious XYZ Widgets Corp., which is attached to suggest a format which will be easy to update, to amend and to use when making annual progress reports.
GENERAL SUGGESTIONS ON WRITING THE PLAN

- As a generator of hazardous wastes, you have been reporting to the State by filing the Annual Hazardous Waste Activity Report. Prepare a year-by-year summary for the past several years of the amount of each waste stream generated and where each originated. Possibly a graphical summary will help to recognize trends and to relate changes to other events such as introduction of a new product line, installation of a new machine, etc.

- It is also a good idea to refer to hazardous waste streams throughout the reduction plan by the "Waste Stream Numbers" used in the Annual Activity Report. This can serve to identify each without repeated descriptive verbiage.

- Because a plan is required only for hazardous waste reduction, write it first on that basis. Once that is complete, it will be easy to add a page stating the goals and timetables for each of the non-hazardous waste streams. All policies and principles in the plan pertaining to hazardous wastes will be equally applicable to solid waste.
WASTE REDUCTION PROGRAM

The recognized need

PLANNING AND ORGANIZATION
- Get management commitment
- Set overall program goals
- Organize assessment task force

Assessment organization and commitment to proceed

ASSESSMENT PHASE
- Collect process and facility data
- Prioritize and select assessment targets
- Select people for assessment teams
- Review data and inspect site
- Generate options
- Screen and select options for further study

Report options selected for evaluation

FEASIBILITY ANALYSIS PHASE
- Technical evaluation
- Economic evaluation
- Select options for implementation

Report final recommended options

IMPLEMENTATION
- Justify projects and obtain funding
- Installation (equipment)
- Implementation (procedures)
- Evaluate performance

Successfully implemented waste reduction projects

Source: USEPA publication EPA/625/7-88/03
WRITING THE PREFACE

Many companies have realized the advantages of waste reduction some time ago, and have taken steps to reduce hazardous wastes before it became required by law. This is the place where you have an opportunity to take credit for those efforts, and their results. If prior activities have reduced wastes to the level of diminishing returns, this is the place to explain that.

The law also recognizes that there are circumstances whereby certain waste streams pose extreme difficulty or expense to reduce. Sometimes the generator (you) exercises little or no control over the amount of waste. For example:

- Customer contracts may require processes, procedures or hazardous materials which cannot be changed;
- The rate at which your facility generates a specific waste may depend entirely on this year’s mix of business;
- Economic evaluation indicates that a major re-tooling or heavy investment for which funds are not available would be required to substantially reduce a waste stream;
- Sometimes the technology required to accomplish significant reduction either does not exist or is not proven.

Here you can explain why the reduction goals for those waste streams are low or even do not exist.

After filling in the table below, list and describe previous efforts which have resulted in reducing the volume or toxicity of each waste stream. You also should explain the reasons for any increasing trends.

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If special circumstances inhibit reduction of some of the streams, list those also.
MANAGEMENT SUPPORT POLICY STATEMENT

No matter how well written or comprehensive a plan to reduce waste may be, implementing it will require involvement by many persons with differing priorities and agendas. If the plan is to work, managers at the highest level must indicate in no uncertain terms that active involvement of employees is not only desired, but expected. The authors of the Act recognized this and included this item to ensure that the plan will not be a "paper tiger".

DO NOT write a statement, take it to management and say "You have to sign this because it's the law". If the policy statement itself is not to become a "paper tiger", it must reflect true commitment of the managers issuing it that waste reduction is a benefit to the company and insurance for the future. Be a cause champion and sell management on the concept. If possible, get the signee or signees to actually write the statement. At least, have them express personal views and then try to incorporate them.

DO NOT take the statement, put it in the official copy of the plan, and file it away.

DO NOT let it appear one day on several bulletin boards to hang there and turn yellow.

DO ask management signees to formally present the policy statement to employees, express their personal commitment and indicate that the same commitment is expected of everyone.

To help formulate a support statement that will work for your company, here are some concepts you may want to incorporate:

- The company's pledge of environmental responsibility to employees and community;
- The company's pledge of compliance with all Federal and State regulations;
- The company's desire to control costs and liabilities, and to promote continuous improvement in areas of quality, productivity and customer satisfaction;
- Managers' personal commitment to pollution prevention through waste reduction;
- Managers' expectation of involvement on the part of all personnel;
- The importance of source reduction as a primary tool for waste reduction;
- Assignment of day-to-day responsibility for waste reduction;
- Pledge of receptiveness to and financial support for waste reduction activity;
- Pledge of incentives for and recognition of significant waste reduction accomplishments.
STATEMENT OF SCOPE AND OBJECTIVES

This section will tell in concise form the following:

SCOPE: What and whom the plan involves, and why.

OBJECTIVES: What the plan is expected to accomplish, and when.

MEANS: What and who will be used to accomplish it.

Choose from the items below what you want to include in your statement.

I. Scope

A. Why will we do it?

✓ To comply with the Tennessee Hazardous Waste Reduction Act
✓ To reduce the company's impact on the environment
✓ To improve corporate image
✓ To protect employees
✓ Other ____________________________

B. Who will be involved?

✓ Corporate management
✓ All employees
✓ Other ____________________________

C. What wastes will we reduce?

✓ RCRA hazardous wastes
✓ Packaging wastes
✓ Office paper
✓ Raw materials
✓ Manufacturing scrap
✓ Wastewater
✓ Energy
✓ Fugitive emissions
✓ Other ____________________________
✓ Other ____________________________
II. Objectives

A. What is our final goal?

✓ To reduce all waste streams (as defined in the plan's Scope) to the technically feasible and economically practicable minimum.

✓ To reduce RCRA hazardous wastes by ____%  

✓ Other ____________________________

B. By what dates?

✓ In calendar year 1994

✓ By June 30, 1995

✓ Each year until eliminated

✓ According to timetable(s) given elsewhere

✓ Other ____________________________

III. Means

A. What will we use to accomplish our objectives?

✓ Waste Reduction Assessment every ____ (months)(year)(years)

✓ New processes, equipment or process changes

✓ Employee training

✓ Raw material substitution

✓ Waste tracking system

✓ Charging waste management cost to generating department

✓ Improved maintenance

✓ Improved scheduling

✓ On-Site recycling

✓ Off-Site recycling

✓ Waste stream segregation

✓ Employee incentives

✓ Other ____________________________

B. Who will be responsible?

✓ An individual (Name ____________________________)

✓ A position (Job Title ____________________________)

✓ A team described elsewhere

✓ Individuals or positions, depending on area of responsibility

✓ Other ____________________________

Now, take your choices and put them together into a one-page or shorter statement.
DETAILED PLAN

This will be the main body of your plan, and in it you should state precisely and in detail how the plan will work.

In outline form, the detailed plan description might have the following elements, which satisfy the requirements of Section 305 (a)(4-6) of the Act.

I. ADMINISTRATION OF THE PLAN

This segment should describe in detail by whom the plan is to be administered, i.e., by an officer, a committee, a team, etc. To avoid up-dating problems, these persons should be listed by titles, rather than by name -- "Environmental Coordinator" instead of "John Whistleblower", for instance. A separate page which can be kept precisely up-to-date can supplement the plan, with the current holders of those titles listed.

It should also describe in detail the duties of the administrator or administrative group. For example:

» schedule and conduct an annual assessment
» meet monthly to review waste reports
» initiate waste reduction projects
» make annual progress report
» update the plan annually
» etc.

II. TRAINING PROGRAM

» who will be trained?
» who will be responsible for conducting training?
» what will be the emphasis of training?
» who will need extra or special training?
» how often will training be repeated?

III. WASTE COST ACCOUNTING

» how will waste costs be tracked?
» how will waste costs be calculated? by whom?
» what will be considered elements of waste cost?
» who will be responsible for tracking waste costs?
» how will waste costs be reported? to whom?
» will waste costs be charged to the generating activity as a budget item?
Elements which should be included in waste costs include:

- Delivered cost of raw materials in the waste, including losses in process;
- Direct labor for all handling, storage, and required HazMat training;
- Departmental overhead plus a share of non-distributed waste management overhead;
- Space charges for storage;
- Treatment Costs, if any;
- Disposal costs, including container rentals, testing or internal laboratory charges, hauling costs, tipping or other disposal fees;
- Allocated portion of liability, compensation and other applicable insurance costs.

IV. Ongoing Nature of the Plan

This should be a statement to the effect that the waste reduction program, so far as possible, will be an integral part of the company's day-to-day operating plan. It should be a reinforcement of similar language in the Policy statement of Management Support.

Indications of this intent would be to make waste reduction training a part of the on-going safety and quality training programs, or to state that future proposals to make changes in operating procedures, plant equipment, etc. will not be approved without prior review for impact on waste generation rates.

HAZARDOUS WASTE REDUCTION GOALS & TIMETABLES

The specific performance goals and timetables for each hazardous waste stream which are required by Section 305(a)(3) and defined in detail in Section 305 (b,c&d) of the Act can better be placed in a separate section, using an individual unit for each waste.

This section will contain the specifics of what is planned for reducing each of the hazardous wastes generated. Each waste will have a separate one- or two-page unit describing:

- The source of the waste - department and specific operation
- A description in some detail of the operation that generates the waste
- A description of measures already in place to reduce the waste.
A history of the generation of the waste, beginning as far back as records are available, continuing through the year just completed.

A detailed description of planned waste reduction measures, giving planned implementation dates and projected reductions upon implementation.

A waste reduction goal for each year as far into the future as possible, but at least through June 30, 1995.

It is in this portion of the plan that the waste reduction goals are actually stated. Section 305(c) states that the performance goals shall be:

"----- quantitative goals, expressed in numeric terms. Whenever possible, the units of measurement should be in pounds (or tons) of waste generated per standard unit of production, as defined by the generator. If the establishment of numeric performance goals is not practical, the performance goals shall include a clearly stated list of actions designed to lead to the establishment of numeric goals as soon as practical."

This is the section which prevents false indications of waste reduction or waste increase caused by fluctuations in the level of business. It also serves another important function.

This provision, which has led to some confusion among persons preparing a plan, is what enables you to define a code whereby your annual report figures are meaningless to anyone who does not have access to your plan. Please note that the generator decides what is the appropriate standard unit of production, then calculates goals and reports performance in terms of that unit of production. The unit of production can be anything normally recorded in the course of business to which the generation of the waste is directly related. Within the same facility, different operations may have different "units of production".

As an example, the XYZ Widgets plan uses 1000 widgets produced in a particular department as the "unit of production" where waste generation is directly related to the number of widgets produced. They report waste generated in those departments in pounds per 1000 widgets. However, where the maintenance department generates parts-cleaner waste, the waste generated is only vaguely related to widgets produced. In that case, the "unit of production" chosen was the number of work orders processed by maintenance, and they report waste generated by parts cleaning in pounds per work order.

Unless drastic changes in overall operations have been made, all that will be necessary when time comes for the annual update is to add a supplement to each unit in this section, noting progress, inserting amendments or other changes, and documenting the reasons for changes in goals or amendments to the timetable.
A FINAL SUGGESTION
FOR A SOLID
WASTE REDUCTION PROGRAM

As discussed earlier, little attention has been paid to anything except hazardous wastes as the plan has been developed. The reason for this is that you are probably writing the plan to comply with the Hazardous Waste Reduction Act of 1990, and have a deadline to meet. However, the plan has been designed to be applicable to a Multi-Media Pollution Prevention Program.

It is strongly suggested that, once the plan is in place for hazardous wastes, the same steps of assessment, prioritization, evaluation and implementation be applied to wastes not strictly covered by the Act. Some things to look at are:

- Air pollutants (e.g., VOC emissions, either fugitive or "point-source")
- Process wastewater
- Used Oils
- Paper products waste (e.g., cardboard, office paper)
- Wood waste (e.g., pallets)
- Plastic waste (e.g., stretch wrap, plastic containers)
- Energy (e.g., heat recovery options, lighting efficiency, power factor improvement, etc.)

When your periodic reviews and updates indicate that your program faces diminishing return in the reduction of hazardous wastes, the items above can be added as new units of the GOALS AND TIMETABLES section, according to whatever priorities your needs assessments dictate.

If a properly structured plan such as this is conscientiously followed, a dramatic reduction in your costs and exposure to future liability from present operations is sure to result. In addition, new products, new equipment and new processes will have been automatically evaluated before production begins. Chances are that in the future, unnecessary wastes and the associated costs will be eliminated before they are generated, which is what pollution prevention is all about.
XYZ WIDGETS CORPORATION
2200 Widget Road
Anytown, Tennessee 38000

HAZARDOUS WASTE REDUCTION PLAN
XYZ Widgets Corporation has always been concerned with protecting the environment and keenly aware of its role as a good neighbor in the community. It has long been a policy that we go well beyond what is legally required and strive for zero discharge of pollutants into the environment, whether on-site or off-site.

We recognized long ago that reduction of wastes has definite economic benefits as well as environmental ones. Consequently, a program called SWAP (Stop Waste, Add Profits) was begun in 1990 under which teams were formed to reduce our wastes to the lowest cost-effective level, beginning with the most "environmentally unfriendly". Under this team approach, the wastes were identified and arranged in order of environmental impact. The processes which caused them to be generated were analyzed to determine what source reduction measures were available for each. The analysis resulted in reduction priority being given to the two of the three largest hazardous waste streams generated at that time. As a result of our waste reduction measures, those two streams were reduced as follows between 1989 and the date of writing this Waste Reduction Plan:

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<tr>
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<td>Varsol</td>
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<td>&quot;MEK&quot;</td>
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<td>&quot;PERC&quot;</td>
<td>15,000</td>
<td>18,500</td>
<td>-3,500</td>
</tr>
</tbody>
</table>

The PERC wastestream was not reduced because of rigid contractual rules. Attempts to obtain contract revisions to remove this barrier have been under way for months, but have been unsuccessful so far. Although we would like to project reduction goals for the PERC wastestream, it is generated making a product under U.S. Department of Defense contracts specifying procedures which preclude source reduction of hazardous materials.

In both cases where our efforts have been successful, reductions have been accomplished by process changes and by training which increased employee awareness of how their actions can be directly responsible for generating unnecessary waste.

Our teams are currently working on all waste streams generated in the plant, hazardous or not. Cost estimates on which to base capital funding to implement further reduction are being made. The goals and schedule for accomplishing further hazardous waste reduction between the present time and the end of 1995 are detailed later.

We are confident we can meet the goals set forth in this plan, especially with strong support from corporate management as stated in the Waste Reduction Policy Statement, a key element of the plan.
This Corporation is committed to excellence and leadership in protecting the environment from being adversely affected by any material emitted from our manufacturing operations.

It is further committed to the concept that wastes of any kind to any medium represent costs which must be reduced to the economically and technically achievable minimums.

We reaffirm here our Corporate goals to provide a safe and healthy environment for employees and to be a good neighbor to the community in which we reside.

Therefore, our policy is, and shall be, to constantly seek opportunities to:

+ **Reduce wastes at the source, through employee training in waste awareness**, through substitution of environmentally friendly raw materials wherever possible, and by ongoing analysis of processes and operations to identify causes of waste,

+ Replace existing waste-generating processes with those which generate fewer or less-hazardous wastes,

+ Revise processes so that wastes can be re-used or recycled within them,

+ Market new or re-designed products whose manufacture results in reduced wastes, or for which existing wastes become raw materials, and

+ Urge suppliers to develop products and procedures which will assist us to reduce wastes generated.

In order to ensure that this policy is carried out, we pledge that we will make available the necessary resources to our employees so that opportunities determined to be feasible will be implemented. To encourage such implementation, economic justification of projects resulting in waste reduction at the source will require a return on investment which is no more than three-fourths of that required for conventional projects.

---

**Chairman & Chief Executive Officer**  
President & Chief Operating Officer

**Vice President, Manufacturing**  
Vice President, Financial

**Vice President, Marketing**  
Vice President, Procurement
XYZ WIDGETS CORPORATION
HAZARDOUS WASTE REDUCTION PLAN

STATEMENT OF SCOPE AND OBJECTIVES

SCOPE OF THE PLAN:

Although this plan is written to meet the requirements of the Tennessee Hazardous Waste Reduction Act of 1990, the XYZ Widgets Corporation's Stop Waste, Add Profits (SWAP) program applies to all hazardous and non-hazardous wastes generated by operations conducted at the Anytown, Tennessee facility. The plan, in future updates, will be amended to include all the following in addition to RCRA Hazardous wastes, which are being given first priority:

+ point source and fugitive emissions to the air,
+ liquid waste discharges to the municipal sewer,
+ raw material and finished goods scrap.
+ non-hazardous solid wastes such as general plant trash, office and lunchroom waste,

The Plan calls for positive commitment to its objectives by Corporate management, and for involvement of every person employed at the facility.

OBJECTIVES OF THE PLAN:

The Plan has two objectives:

1. To reduce all waste streams (as defined in the statement of the Plan's scope) to the minimum quantity which is technically feasible and economically practical.

2. To continue in perpetual effect as an instrument which will:
   + Maintain Corporate waste awareness
   + Ensure on-going analysis of factors influencing waste generation
   + Provide continuing employee training

ESSENTIAL ELEMENTS OF THE PLAN:

1. A facility-wide waste assessment will be conducted no less frequently than annually. The assessment will be conducted by the Plan's administrative team. The plant-wide
assessment will be scheduled so that its results will be available to Process Teams when they establish their annual goals.

2. All new processes and all major process changes will require a waste stream impact study.

3. Employee training on waste reduction will be embedded in the existing and on-going Safety and OSHA Employee Right-to-Know training program. For those employees who are required to have special hazardous materials training, a waste-reduction component will be incorporated in that training as well.

4. Each Process Team will be required to measure and track all wastes generated by the team's activities. A process team will be responsible for and bear the expense of its waste streams, which will be a part of the team's cost-budgeting structure. Tracking of wastes will be accomplished by a mass-balance technique which will ensure that all materials are truly accounted for.

5. Financial tools will be utilized so that the full cost impact of each waste stream generated is tracked.

6. Each Process Team will establish a waste reduction goal and an implementation schedule at the beginning of each year. A progress report and the next year's goals and implementation schedule will be submitted by January 5 of each year.

DESCRIPTION of the PLAN

1. Administration

The Waste Reduction Plan will be administered by a SWAP Team to be headed by the Vice President, Manufacturing. The team will be composed of the following:
+ Technical Coordinator
+ Environmental & Safety Director
+ Maintenance Superintendent
+ Purchasing Agent
+ Staff Accountant
+ One representative from each Process Team

The duties of this team will include:
+ Administer the plan
+ Schedule and conduct the annual facility-wide assessment
+ Appoint sub-teams to analyze assessment results, consider options and make recommendations for the entire team's consideration
+ Meet regularly to review waste data, project progress and make new assignments
+ Report findings, make final recommendations, and initiate project requests for implementation and corrective action
Prepare the annual progress report and update the Plan and the goals and implementation schedule as and if necessary.

2. Training and Worker Involvement

Waste Reduction will be incorporated into the existing training curriculum wherein employees are trained on the general nature of chemical hazards, safe operating procedures and use of MSDS’s. Employees in a process area will be required to evaluate their own area’s waste streams and be provided with resource material which describes the technology available and currently used for reduction of waste streams of similar nature or in similar processes. Major emphasis will be on preventing waste generation by improved procedures, material substitution and process changes.

Employees will participate in tracking the costs of wastes they generate and will be expected to use this information in continuous improvement of the process.

3. New Processes, New Products and Major Changes

New processes and products or major changes will be installed only after an analysis of the waste stream impact. New start-ups and major changes will require an estimate of the type and volume of the waste generated, its environmental impact and related costs. Product development groups will be required to assess waste impact early in their design considerations. Any significant additional waste generated will require a challenge to the design before work proceeds. Manufacturing teams will need to be apprised early in the development as to the nature of the required manufacturing process and asked for input on the anticipated waste streams’ impact. Production teams will have a strong incentive to challenge changes and new products because they are ultimately responsible for managing and must budget the cost of their waste streams.

4. Waste Management Cost Accounting

A mass balance analysis technique (total pounds of all materials in = total pounds of all materials out) will be used to identify all input and output streams to each individual process. Once waste streams have been identified and quantified by this analysis, waste will be reported in weight per unit of production. For example, the process manufacturing Type A Widgets will report all waste streams in pounds per 1000 Type A Widgets made.

This information will be logged by operating personnel on a shift-by-shift basis and turned over to accounting for cost calculation. Because of the differing nature and processing involved in the various wastes, waste costs will be established in dollars per pound on a case-by-case basis. In the case of product rejects, the process team will classify rejects in five categories, according to the value added by manufacturing at the point of rejection.
The elements of the final waste cost will include such items as those listed below:

+ Purchase cost of raw materials in the waste, (including those lost in the process)

+ Labor,

+ Overhead charges (departmental plus a share of waste management overhead costs),

+ Waste storage costs,

+ Waste treatment costs, if applicable,

+ Waste disposal costs, including storage container rentals, laboratory fees, hauling and disposal fees, etc.,

+ A portion of the facility's liability and workmen's compensation insurance costs (the Vice President, Financial, or his designee, will determine allocation rules).

For example, fugitive emissions or evaporation losses from the degreasers will be included when computing waste solvent cost.
HAZARDOUS WASTE REDUCTION PLAN

HAZARDOUS WASTE REDUCTION GOALS
AND
TIMETABLES
A. Waste Stream No. 1: Perchloroethylene (PERC); EPA Waste Code F001

SOURCE
Type X Widget Department

OPERATION GENERATING WASTE
Vapor degreasing to remove machining coolant prior to in-process inspection

BARRIERS TO REDUCTION
Type X Widgets are produced under a DoD contract which specifies the process in great detail. PERC is used in this department in a vapor degreaser to remove chips and oils resulting from first-stage machining so that the parts can be individually inspected. Because of potential corrosion by hydrochloric acid resulting from solvent degradation, the DoD contract specifies replacement of the solvent charge every 100,000 widgets. The waste is generated when the degreaser is drained and solvent replaced. Given this lack of control, potential for reducing this waste is very poor.

WASTE REDUCTION MEASURES PREVIOUSLY IMPLEMENTED
Considerable reduction has been accomplished in the quantity of PERC lost at this location as drag-out and fugitive emissions by modifying operating procedures. However, no reduction in RCRA hazardous waste has been accomplished because of the requirement that the solvent be replaced on a regular schedule.

GENERATION HISTORY
1989: Produced 6,000,000 Widgets, Generated 15,000 pounds waste
Waste Generation Rate = 2.50 pounds per 1000 Type X widgets.
1990: Produced 6,500,000 Widgets, Generated 16,250 pounds waste
Waste Generation Rate = 2.52 pounds per 1000 Type X widgets.
1991: Produced 7,400,000 Widgets, Generated 18,500 pounds waste
Waste Generation Rate = 2.50 pounds per 1000 Type X widgets.

WASTE REDUCTION MEASURES PLANNED
Technical liaison has been established with DoD with the objective of eliminating use of this solvent. Because of our success in totally eliminating solvent-cleaning in manufacturing Type Z Widgets, we expect to eventually negotiate contract revisions with DoD which will allow us to change to an aqueous cleaner. This technique is now in successful use making Type Z widgets. All plans to reduce hazardous waste in this operation are held in abeyance, pending definite action by DoD. We would be able to implement the change about ten weeks after the contract revision.

WASTE REDUCTION GOAL
Technology already in use in this facility could eliminate this waste stream. XYZ Widgets has no control over when the decision to allow its use may come. Therefore, no reduction goal or implementation date has been set.
B: Waste Stream No. 2: 1,1,1 Trichloroethane (TCA); EPA Waste Code F001

SOURCE
Type Z Widget Department

OPERATION GENERATING WASTE
Vapor degreasing of widgets prior to deburring and buffing.

WASTE REDUCTION MEASURES ALREADY IMPLEMENTED
Whereas this department used a vapor degreaser and TCA until late 1989, the process no longer uses vapor degreasing, but relies on a rinse of the parts in clear, ambient-temperature water to accomplish the same end. This was made possible by replacing oil-based cooling medium in the preceding machining operation with a water-based synthetic coolant.

GENERATION HISTORY
1989  Produced 6,120,000 widgets, generated 15,000 pounds waste
      Waste Generation Rate = 2.50 pounds/1000 Type Z widgets
1990  Produced 7,050,000 widgets, generated 800 pounds waste
      Waste Generation Rate = 0.11 pounds/1000 Type Z widgets.
1991 and Future -- No RCRA waste to be generated in this operation.
      Waste Generation Rate = 0.00 pounds/1000 Type Z widgets.
C. Waste Stream No. 4: Waste Varsol (Mineral Spirits); EPA Waste Code D001

SOURCES
Maintenance Shop; Tool and Die Shop

OPERATIONS GENERATING WASTE
Maintenance mechanics use Varsol-charged Safety-Sink cleaning stations to wash parts or anything they may have to clean up. A service removed dirty solvent and replaced it with clean on a regular three-week schedule. There were three sinks in the maintenance shop in 1989. In that year, these sinks were responsible for 7,500 pounds of waste manifested for off-site recovery.

The tool and die shop has two 250-gallon vats of Varsol into which stamping dies are immersed for cleaning. The solvent was replaced every nine weeks by the same company that serviced the parts sinks. They were responsible for generating 31,500 pounds of waste solvent in 1989.

WASTE REDUCTION MEASURES ALREADY IMPLEMENTED
During 1990 and 1991, the use of Varsol for cleaning was extensively studied, including study of work practices and evaluation of how well the existing operations were utilizing the solvent's oil-removal capacity. As a result of that study, the following measures were taken:

+ The replacement cycles for the sinks in maintenance were increased from three weeks to six weeks.
+ One of the die-cleaning vats was taken out of service.
+ The replacement cycle for the remaining die-cleaning vat was increased from nine weeks to twelve.
+ Drainboards were added to the die-cleaning vats to allow recovery of solvent dragged out on dies.

As a result of these measures, the total waste Varsol shipped off-site was reduced as indicated below.

GENERATION HISTORY
1. Maintenance Department:
   Waste Generation Rate = 0.67 pounds per workorder
   1990 Processed 12,100 Maintenance Workorders, generated 4250 pounds of waste.
   Waste generation Rate = 0.35 pounds per workorder
   1991 Processed 11,300 Maintenance Workorders, generated 3800 pounds of waste.
   Waste Generation Rate = 0.34 pounds per workorder
D. Waste Stream No. 5: Methyl Ethyl Ketone (MEK); EPA Waste Code F005

SOURCE
Final Packaging and Inspection

OPERATION GENERATING WASTE
Type Y widgets have a component made of highly polished stainless steel. To prevent marring of the polished surface, the stainless steel sheet is purchased with a protective paper attached by pressure-sensitive adhesive. Removal of traces of adhesive and bits of paper from the finished product is accomplished by wiping with a rag wet with MEK. The operator's supply of MEK is discarded when it becomes dirty enough to leave a dull film on the surface after it evaporates.

WASTE REDUCTION MEASURES ALREADY IMPLEMENTED
None -- All alternative methods of cleaning tried thus far have failed.

GENERATION HISTORY
1989 Produced 10,400,000 Type Y widgets, generated 1050 pounds of waste. Waste Generation Rate = 0.10 pounds/1000 Type Y widgets
1990 Produced 9,950,000 Type Y widgets, generated 1010 pounds of waste. Waste Generation Rate = 0.10 pounds/1000 Type Y widgets
1991 Produced 11,785,000 Type Y widgets, generated 1200 pounds of waste. Waste Generation Rate = 0.10 pounds/1000 Type widgets

WASTE REDUCTION MEASURES PLANNED
At present, there are no proven alternatives known to us. We will continue an intensive program of training and waste awareness, but reduction of any significant magnitude will be difficult to accomplish, given the present state of training.

It is planned to investigate the following potential source-reduction options. If one should become available, it will be thoroughly evaluated from an economic standpoint, and implemented if it is not cost-prohibitive. It should be noted that the market for Type Y widgets is extremely competitive, and the profit margin is one of the lowest in our product line.
+ Obtain polished sheet from supplier with water-removable protective film;
+ Continue search for a suitable substitute cleaning material

WASTE REDUCTION GOALS
It is our intention to eliminate this waste stream entirely, if an alternative method which is both effective and economically feasible can be found.

Our goal is that the Waste Generation Rate for this waste stream will be reduced 10%, or to 0.09 pounds per 1000 Type Y widgets by June 30, 1995.
2. Tool and Die Shop:
1989  Produced 23,000,000 widgets, generated 31,500 pounds of waste.
      Waste Generation Rate = 1.37 pounds per 1000 widgets
1990  Produced 23,500,000 widgets, generated 21,900 pounds of waste.
      Waste Generation Rate = 0.93 pounds per 1000 widgets
1991  Produced 22,950,000 widgets, generated 8330 pounds of waste.
      Waste Generation Rate = 0.36 pounds per 1000 widgets

WASTE REDUCTION MEASURES PLANNED

The following options are being evaluated from a technical and economic standpoint:
+ Replace all but one of the solvent type parts sinks in maintenance with a heated, agitated cleaning tank using a water/detergent solution as cleaning medium. This should allow us to reduce this department's solvent waste by another 50%.
+ Purchase and install a spray cleaner with air-drying capability for die cleaning. This should eliminate use of solvent cleaners in tool and die shop except for small hand-wipe operations.

WASTE REDUCTION GOALS
1. Maintenance Department

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<th>Lbs.Waste/Workorder</th>
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2. Tool and Die Shop

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<th>Evaluation Date</th>
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